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FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

October 22,1999
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N1-96-2

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Contaminated Sediment Management Guide for NSRP Shipyards
Appendix 5: Treatment Technologies

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

Report Documentation Page

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Index of Treatment Technologies

Technology Name	Technology Category*
3L Filters Ltd., Oil/Water Separation System	4, 10
Alberta Taciuk Process	1
ALTECH Technology Systems Ltd., Bioremediation	11
ALTECH Technology Systems Ltd., Soil Washing	3, 6, 7, 9, 10
Alternative Remedial Technologies Inc., Soil Washing	3
American Combustion Pyretron Oxygen Burner	8
ARC Sonics, Sonically Enhanced Oxidation/Metals Extraction	3, 10
ART International Inc., Low Energy Solvent Extraction Process (LEEP)	6
Ashwarren Hydrocarbon Recycler	1
Ashwarren Metal Encapsulation	2
Astec (SPI Division), Thermal Desorption	1, 2, 4, 5, 6, 8
Atomic Energy of Canada Ltd., In-Situ Stabilization	2
Atomic Energy of Canada Ltd., Joule Melter	1
Atomic Energy of Canada Ltd., Radiolytic Dechlorination	9
Atomic Energy of Canada Ltd., Solidification/Stabilization	2
B.A. Brown Thermal Oxidation	8
Babcock & Wilcox, Cyclone Vitrification Technology	12
Base Catalized Decomposision Process (BCDP)	9
Batelle Northwest In-Situ Vitrification	1
Beaver Dredging Pre-Treatment	4
Bennett Remediation Technologies, Thermal Oxidizer	1, 8
Bergmann Soil/Sediment Washing	3

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
Bio Separation Ltd., Biomagnetic Separation and Extraction	6, 7
Bioforj Ont. Ltd., Enretech Bioactive Absorbents	2, 11
BioGenesis Enterprises Inc., BioGenesis Soil and Sediment Washing Process	3, 6, 7
Biogenie Biopile Process	11
Biorem Inc., Biological Remediation of Contaminated Soil	11
Bird Engineering, HET Slurry Decontamination Process	11
Bos Engineering, Settling Basin Optimization	4, 10
Bovar Retech Bioremediation	11
Center for Hazardous Materials Research, Acid Extraction Treatment System	7
Ceramics Kingston Biochemical Process	11
CET Bioremediation	11
CET Chemical Fixation and Solidification (CFS)	2
CET Vapor Extraction System (VES)	6, 7
CF Systems Solvent Extraction Technology	6, 7, 9
Chem-Security Stabilization	2
Cintec Environment Inc., Ogden CBC (Circulating Bed Combustor)	8
CleanSoils, Thermal Desorption	1
Cognis Terramet Metal Leaching Technology	3, 7, 9, 10
Colloid Sorbond Solidification	2
Comrie Inorganic Binders	2
Coreco, Rotary Kilns	1, 2, 4, 5, 6, 7, 8, 9, 10, 12
CWM Chem-Matrix Stabilization/Solidification	2

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
CWM DeChlor/KGME Process	9
CWM Enrac Fuels Conversion System	1
CWM PO WW ER Treatment System	1
Davy Intl In-Pulp Extraction Process	7
Davy Torbed	1
Dehydro-Tech Corp., Carver-Greenfield Process	6
Denver Process Technologies Inc., DPT Chemical Stabilization Process	2
Derrick, Solid/Liquid Separation Technology	4, 10
Detox Industries Slurry Phase Biodegradation	11
Dravo Rotocel	6, 7
Drillco Foundation Co., Ltd., In-Situ Remediation	9, 11
Dufferin Solidification	2
E.I.L. Environmental Services, Inc., Bioremediation	11
Ecofix, Stabilization/Fixation	2, 4, 9, 10
Ecological Systems, Technology Inc., Algal Scrubber	11
Ecotechniek Ecogrind	1
Ecotechniek Extraction	6, 7
Ecotechniek Incineration	1
Ecotechniek Volker/Esdex Pre-Treatments	4
EER Spout Bed Incineration System	8
Electrokinetics Rapid In-Situ Bio-Electrokinetic Remediation	11
Electrokinetics Soil Processing	6, 7

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
Eli Eco Logic Process	1, 9
EmTech Solidification/Stabilization Process	2
Ensotech Ensol and Landtreat Process	2, 9
Ensotech Landtreat and Petroxy Process	9
Epoc Water Exxflow and Exxpress	3, 10
Equipement et Machines de L'Ouest, Burger Press	4, 5
Etus Inc.,/Four Seasons Environmental, TR-DETOX Heavy Metal Stabilization	2, 9, 10
Extract S.A., EXTRACT System	3
Exxon Chemical Oxidation/Cyanide Destruction Process	9
Facet Quantek Coalescing Place Separator	4, 5
FSCL Fujibeton	2
General Atomics Circulating Bed Combustor Incinerator	8
Gorman Incineration	8
GPEC, Hazardous Waste Fixation/Stabilization	2
GPEC, Low Temperature Thermal Desorption	1
Grace Dearborn, Cycled Daramend Bioremediation	11
Grace Dearborn, Daramend Bioremediation	11
GRC Apeg-Plus Process	9
Groundwater Technology, Ozone Sparging Process	9
Gulf Canada, Bioremediation	4, 11
Haecon, BIO-C	11
Heidemij Cum-Bac	11

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
Heidemij/IHC Froth Floatation	4
Hepaco Inc., Bioremediation	11
Hepaco Inc., Soil Fixation/Stabilization	2
Horsehead Resource Development Co. Inc., HRD Flame Reactor	1
Hrubetz Environmental Services, Inc., Hrubout ™	1
HSM Ghea Extraction	6, 7
HTM Global Corporation, Soil Micronization/Air Stripping Process	2, 3, 6
Hygrex-Spehr Waste Reduction System	4, 5
IHC Metal Extraction	7
Innovat Mackie Vat Leaching Jig (MVLJ)	6, 7
Innovat Solidification and Stabilization	2
In-Situ Fixation Inc., Dual Auger System - Bioremediation	2, 9, 11
In-Situ Fixation Inc., Dual Auger System - Solidification/Stabilization	2, 9, 11
Institute of Gas Technology, Biological-Chemical Process	11
Institute of Gas Technology, Extraction/Biological Degradation Process	6
Institute of Gas Technology, Two-Stage Combustor	8
International Waste Technology, Advanced Chemical Treatment	2, 9
ISI Krofchak Solidification and Stabilization	2
ITC Thermal Separator	1
Izone Ozone Oxidation-Reduction Chamber	9
J.R. Simplot Co., SABRE Process for Nitroaromatic-Contaminated Soils	11
Jacques Whitford Environment Ltd., Bioslurping Treatment System	11

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
Jan de Nul N.V., DJN Dewatering	3, 4, 10
Jan de Nul N.V., DJN Elutriator	3, 4, 10
Jan de Nul N.V., DJN Flotation	4, 9, 10
Jan de Nul N.V., DJN Fyto-Sanitation	5, 11
Jan de Nul N.V., DJN Hydrocyclone Separation	3, 4, 10
Jan de Nul N.V., DJN Pyrolysis	1, 5
Jan de Nul N.V., DJN Soil Washing/Flotation	3, 5, 9, 10
John A. Kitchen Ltd., Pulse Process	1
Kenox Wet Air Oxidation	1, 4, 9
Klohn-Crippen, Chem Tech Soil Treatment Process	3, 5, 7, 9, 10
Lupien, Rosenberg Consultants, Inc., Electronic Removal of Heavy Metals	12
Micro-Bac International Inc., Bioremediation	11
MK Thermal Treatment Units	8
MRS Modular Vapor Extraction Systems (VES)	6, 7
Natural Environment Recovery Inc., Ex-Situ Bioreactors	11
NBM Ananemingsbedrijf Indirect Thermal Desorption	1
NBM Bodemsanering Indirectly-Heated Thermal Desorption	1
NBM Bodemsanering Soil Washing Process - Metals and Hydrocarbons	4, 5
NRCC Adsorption Approach	6
NRCC Solvent Extraction Soil Remediation (SESR)	6
NWRI Limnofix (In-Situ Chemical Injection)	2, 9
OHM Remediation Services Corp., Infrared Incineration System	8

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
OHM Remediation Services Corp., Liquid Soilds Separation	3, 6, 8, 9, 10, 11
OHM Remediation Services Corp., PY*ROX 8200 Mobile Rotary Kiln Incinerator	1, 8
OHM Remediation Services Corp., Slurry-Phase Biological Treatment	3, 11
OHM Remediation Services Corp., X*TRAX (Thermal Desorption)	1, 6, 10
Oleophilic Sieve (TM - Jan Kruyer)	6, 7
Ortech Electrochemical Process	9
Philip Environmental Services Corp., Bioremediation	11
Philip Environmental Services Corp., Eco-Safe	9, 10
Philip Environmental Services Corp., Thermal Desorption	1, 10
PSI Technoloties, MelDAS (Metals Immobilization and Decontamination)	1
R. Cave Composting	11
Recycling Science International, Desorption and Vapor Extraction (DAVE) System	1, 5, 6
Resources Conservation Co., Basic Extraction Sludge Treatment (B.E.S.T.)	3, 4, 5, 6, 9, 10
Retech Plasma Centrifugal Furnace	8
RTI ReTec Thermal Desorption	1
Sanexen Biolysis Process	11
Sanexen Sinre/DRAT	9
SBP, Slow Release Biocomposites for In-Situ Treatment of Sediments	11
Shirco Infrared Thermal Destruction	8
Silt N.V. Bacteriological Remediation	11
Silt N.V. Extraction	6, 7
Silt N.V. Fixation	2

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
Silt N.V. Fraction Separation and Dewatering	4
Sipac Soliroc	2
Sitl N.V. ITORICS System	7, 11
Solidwaste Technology L.P., Urrichem Process	1, 2, 3, 4, 5, 9, 10, 11
Sonofloc Process	4, 5
SRE Solv-Ex	6, 7
SRS SAREX Chemical Fixation Process	2
SRS SAREX MX-1500 Centrifuge	4
SRS SAREX MX-2000 Thermal Dryer	1, 4, 5
SRS SAREX MX-2500 B.D.A.T. Thermal Desorber	1
Steffen Robertson & Kirsten, Froth Flotation	7
Steffen Robertson & Kirsten, Wet High Intensity Magnetic Separation (WHIMS)	7
Tallon Vitrokele Soil Remediation Technology	6, 7
Terra-Kleen Soil Restoration Unit	6, 7
Terrateam Composting Biotreatment	11
Texarome Process	6, 7
Thermo Design Engineering Ltd., Clean Soil Process	3, 4, 6
Toray Filters	4, 5
Trident Trifirmex Process	2
TriWaste Reduction Services, Thermal Desorption Unit	1
TriWaste Reduction Services, Thermal Phase Separation Process	1
University of Wisconsin Biological Treatment	11

* See the last page for category key

Index of Treatment Technologies

Technology Name	Technology Category*
University of Wisconsin Extraction	6, 7
University of Wisconsin, Advanced Oxidation Process	9
VHBZ Mobile Silt Separation and Treatment Plant	4
VKI Plasma Waste Destruction Process	1
Vortec Corporation, Oxidation/Vitrification Process	12
Waste Stream, Bioremediation	11
Wastech Molecular Alteration/Stabilization	2
Wastewater Technology Centre, Generic Solidification Formulation Development	2, 4
Wastewater Technology Centre, Self-Sealing/Self-Healing Waste Containment System	12
WBB Hydro SILT-PAC	4
Weston Low Temperature Thermal Treatment (LT3) System	1
Xetex Environmental Corporation, Xechlor Process	9
Zimpro Wet Air Oxidation	1

* See the last page for category key

Index of Treatment Technologies

Key
1 - Thermal
2 - Stabilization/Fixation
3 - Soil Washing/Volume Reduction
4 - Pre-Treatment
5 - Post-Treatment
6 - Organic Extraction
7 - Metal Extraction
8 - Incineration
9 - Chemical
10 - Physical
11 - Biological
12 - Electrokinetic, Vitrification, and Miscellaneous

3L Filters Ltd., Oil/Water Separation System

20-Jan-98

TechID 345

Technology Type: Pre Treatment, Physical
Adsorption

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX

Media Treated: Sediment Ex-Situ

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

3-L Filters "Oil/Water" Separators incorporate proprietary filtration elements, design and media in the removal of hydrocarbon contaminants from ground water, wash water and other liquid wastes. Following the analysis of a "representative" sample at 3-L's lab facilities, Oil/Water Separator systems can be adapted to specific site requirements.

The Oil/Water Separator System consists of one or more separation stages (housings). The number of stages required is determined by each specific application. Each System can consist of the following stages:

* The first-stage, a prefilter, removes suspended solid (particulate) contamination that may be present in the stream.
* The second-stage unit(s) removes the free hydrocarbon components by utilizing a combination of an oilophylic pad and hydrophylic fibreglass coalescing elements.
* The final stage consists of Granular Activated Carbon Adsorbers (GAC's).

The greatest advantages of 3-L Filters Oil/Water Separator systems are:

* Systems are totally modular/adaptable for various types of contamination, flow rates and automation requirements (custom systems are also available).
* Systems consist of vertical pressure vessels suitable for high flow rates and small foot plate requirements, thus reducing overall system size.
* Variable operating pressures.
* Convenient swing bolted closure allows for quick access during cartridge changeouts, thus reducing down time and labour costs.
* High efficiencies

Limitations: No surfactants, detergents, PCB's.

Efficiency Description: 99.99% (oil removal)

Government Funding: GASReP, ETP

Environmental Concerns: Sample ports for monitoring discharge.

Health & Safety Plan Available: ☐

Regulatory Approvals Provisional Certificate of Approval No. A650037

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$8.00**

NOTE: Cost information for this process is usually given per m³, not per tonne.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Collected oil, sludge.

Developers:

3L Filters Ltd.
427 Elgin St North
Cambridge, Ontario
Canada N1R8G4
Notes

Contact: Warkentin, Don
Phone: (519) 621-9949 Ext:
Fax: (519) 621-3371
Email:

Vendors:

3L Filters Ltd.
427 Elgin St North
Cambridge, Ontario
Canada N1R8G4
Notes

Contact: Warkentin, Don
Phone: (519) 621-9949 Ext:
Fax: (519) 621-3371
Email:

Literature References:

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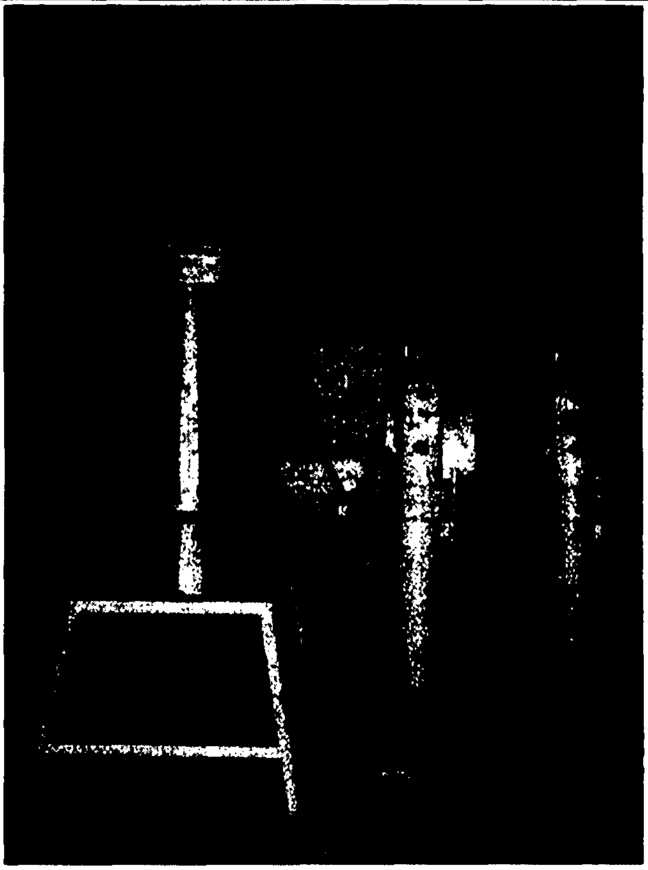

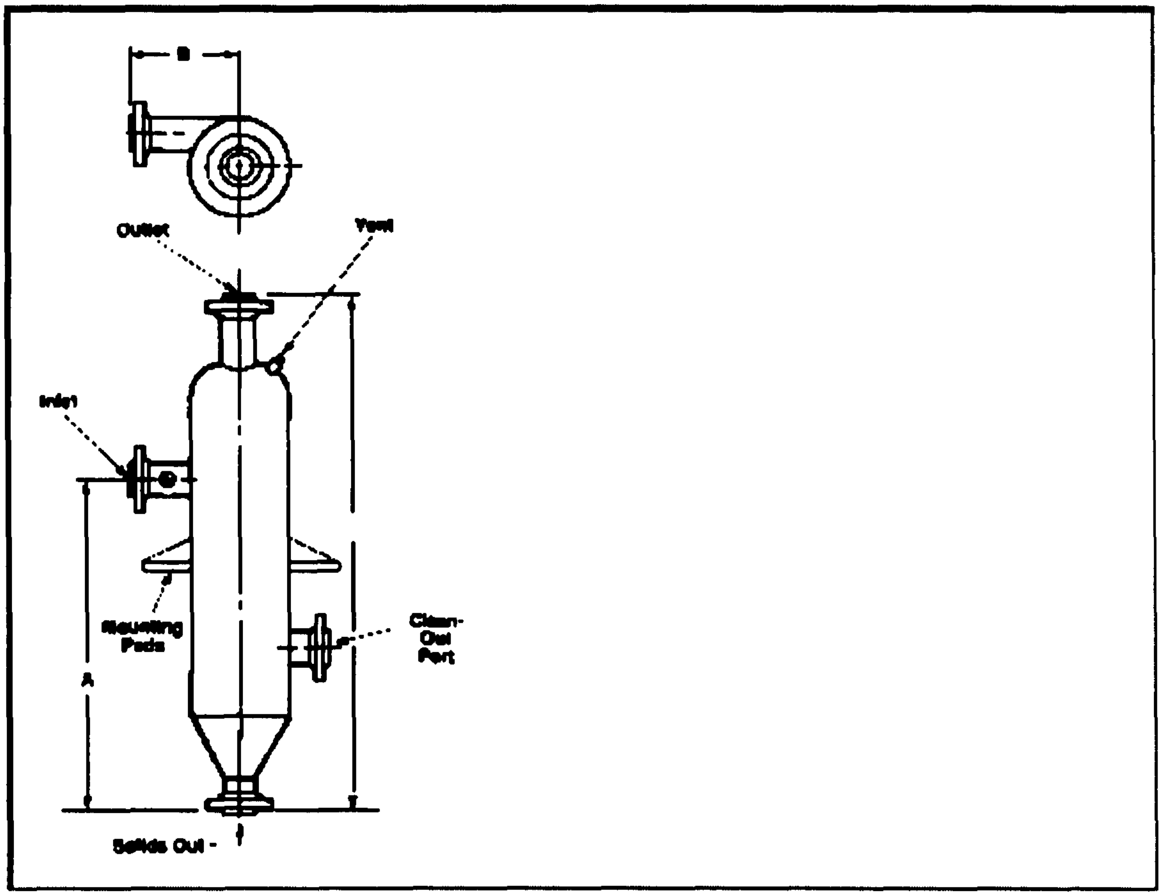

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3L Filters Ltd., Oil/Water Separation System

20-Jan-98

Project: CGT Treatment Project — **Year: 93**

Location: Cambridge, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
Canadian General Tower	Paul Plotz	(519) 623-1630

Not Audited

Feed Rate (Tonne/hr): 0.23 — Amount Treated (Tonne): 3785

Treatment Cost (US$):

Setup Time (days): 14 — Breakdown Time (days):

Media Treated: Groundwater

Contaminants Treated:

	Untreated (1992):	Treated (1995):	% Removal
Di-n-octyl Phthalate	26000 ppm	28.1 ppm	99.9
1,1 - Dichloroethylene	1310 ppm	46.6 ppm	96.4
Chloroethane	2520 ppm	23.7 ppm	99.1
Vinyl Chloride	181 ppm	<10 ppm	94.5

Emissions/ByProducts:

Description: Ongoing treatment. Depressing the water table. Allowing free-product to go to top of wells. System acts as pre-filter and clean-up mechanism. Self-cleaning system. Feed rate now going to 5 gal./min. from 2 gal./min. Initial cost $37,000 (US). Variable cost per year now $ 3,000 (US).

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Alberta Taciuk Process

11-Dec-97

Technology Type: Thermal

Contaminants Treated: PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The Alberta Taciuk Process was originally developed to recover oil from oil sands. The key component of this process is the Taciuk Processor, a horizontal rotating processing vessel. Waste feed undergoes pyrolysis during which light hydrocarbons are vapourised and heavy hydrocarbons are broken down by vapourization and thermal cracking. The organics remaining in the non-gaseous phase carbon are oxidized to generate process heat.

The hydrocarbon vapours are recovered by condensation after separation from the solids. In the processor, patented sand seals and a sand recycling system facilitate the separations and transfer of heat. Product flue gases, steam and hydrocarbon vapours exit this unit for further treatment, while solids are simply cooled and wetted for discharge. Though the process is capable of treating sludges, any excess water in the feed simply decreases throughput capacity of the process and thus increases treatment times and cost for quantities or projects.

From SITE demonstrations: No dioxins or furans are created, and no volatile or semivolatile organic degradation products or leachable VOC/semi-VOC compounds were detected in treated soil.

Decontam, Inc. and SoilTech ATP Systems have the rights for this technology in Quebec and the U.S.A., respectively. The technology is owned by AOSTRA and manufactured by UMATAC.
(formerly known as Aostra Taciuk Process)

Limitations: Does not treat metals. Solids must be dewatered to approximately 20% moisture prior to treatment.

Efficiency Description: over 99% PCB removal

Government Funding: Great Lakes Cleanup Fund, DESRT, SITE, Superfund

Environmental Concerns: Needs local approval for air emissions.

Health & Safety Plan Available: ☒

Regulatory Approvals US EPA approved

Setup/Feed: Setup Time (days): 15 Breakdown Time (days): 10

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$100.00 – $350.00** Average Cost (US$/Tonne): **$150.00**

Feed rate variable: depends on plant size. To date, largest plant achieves rate of 10 tonne/hour.
Costs range from $100 to $350 depending on project and materials.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Oil, water (requiring treatment), cleaned solids, treated gases

Developers:

UMATAC Industrial Processes
210-2880 Glenmore Trail S.E.
Calgary, Alberta
Canada T2C 2E7
Notes

Contact: Ritcey, R.M.
Phone: (403) 279-8080 Ext: 18
Fax: (403) 236-0595
Email:

Vendors:

SoilTech ATP Systems, Inc.
800 Canonie Drive
Porter, IN
USA 46304-
Notes

Contact: Hutton, J.
Phone: (219) 929-4343 Ext:
Fax: (219) 926-7169
Email:

Decontam, Inc.
2401 Lapierre
Lasalle, Québec
Canada HBN 1B7
Notes

Contact: Turcotte, P.S.
Phone: (514) 364 6860 Ext:
Fax: (514) 365 2964
Email:

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Alberta Taciuk Process *11-Dec-97*

Literature References:

Author: **SoilTech Inc.**
Title: The Taciuk Process Technology: Thermal Remediation of Solid Wastes and Sludges, Technical Information Manual
Journal: Date:

Author: **Ritcey, R.M., Taciuk, W.**
Title: Taciuk Processor for Treatment of Contaminated Wastes
Journal: AOSTRA Conference, Advances in Petroleum Recovery and Upgrading Technology, Edmonton, Alberta Date: **Jan 1987**

Author: **American Petroleum Institute**
Title: Evaluation of Treatment Technologies for Listed Petroleum Refinery Wastes
Journal: Publication No. 4465 Date: **May 1988**

Author: **Vorum, M., Montgomery, A.H.**
Title: The Taciuk Process Technology for Anaerobic Pyrolysis of Solid Waste and Sludges
Journal: Canonie Environmental Services Corporation Date: **Jan 1989**

Author: **Turner, L.R.**
Title: Treatment of Oilsands and Heavy Oil Production Waste Using the AOSTRA Taciuk Process
Journal: Conference on Oil Field Production Wastes, Calgary, Alberta Date: **May 1989**

Author: **Ritcey, R.M.**
Title: Anaerobic Pyrolysis of Solid Wastes and Sludges - The AOSTRA Taciuk Process System
Journal: HAZTECH Canada Conference, Edmonton, Alberta Date: **Oct 1989**

Author: **Turner, L.R., Goodwin, S.**
Title: The AOSTRA Taciuk Process - The Flexible Alternative for Oily Waste Treatment
Journal: Alberta Oil Sands 2000 Conference, Edmonton, Alberta Date: **Mar 1990**

Author: **UMATAC Industrial Processes/ADS UMA Inc.**
Title: Treatability Tests Report: The AOSTRA Taciuk Process Technology Tests for the Wastewater Technology Centre
Journal: Prepared for Great Lakes Cleanup Fund Date: **Apr 1991**

Author: **Taciuk, W., Ritcey, R.M.**
Title: Flexibility in Wastes Remediation with Pyrolysis - The Aostra Taciuk Process
Journal: 84th Annual Meeting, Air & Waste Management Association Date: **Jun 1991**

Author: **Wastewater Technology Centre**
Title: AOSTRA Taciuk Process Treatability Tests
Journal: GLCF Fact Sheet Number 3 Date: **Sep 1992**

Author: **Hutton, J.H., Shanks, R.**
Title: Thermal Desorption of PCB-Contaminated Waste at the Waukegan Harbor Superfund Site (A Case Study)
Journal: US EPA Fourth Forum on Innovative Hazardous Waste Treatment Technologies Date: **Nov 1992**

Author: **Hutton, J.H., Trentini, A.J.**
Title: Thermal Desorption of Polynuclear Aromatic Hydrocarbons and Pesticides Contaminated Soils at an Ohio Superfund Site: A Case Study
Journal:
Date: **Jan 1994**

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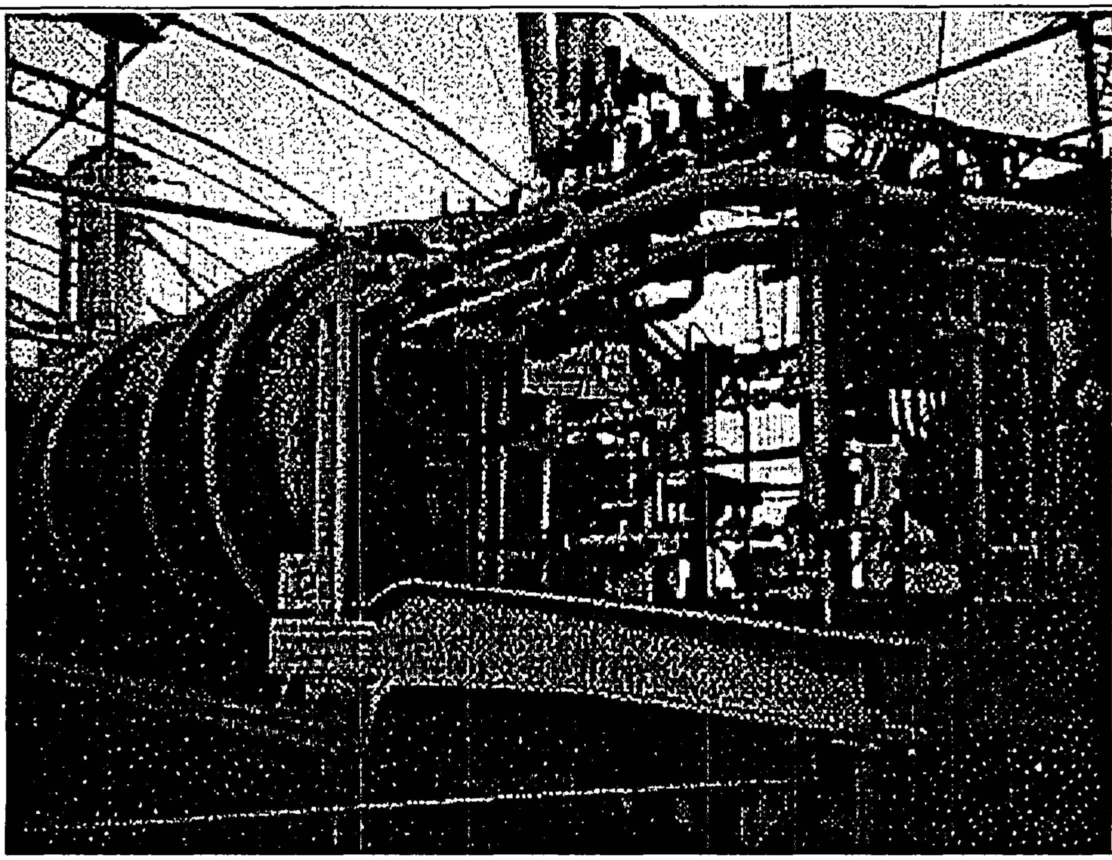
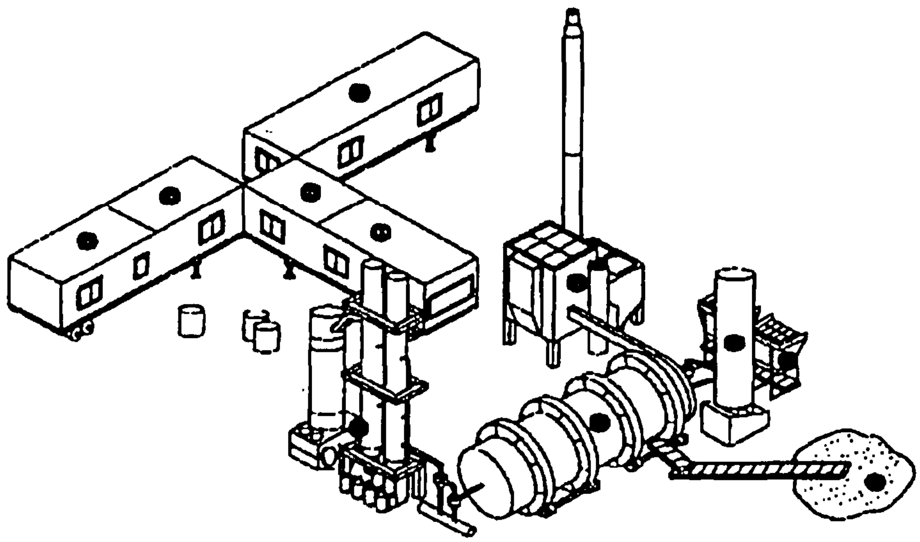
Alberta Taciuk Process





1. ATP (3.6 m Diameter, 14.2 m Length)
2. Hydrocarbon Recovery System
3. Preheat Vapor Recovery System
4. Flue Gas Treatment System
5. Feed Hopper
6. Treated Soils
7. Offices
8. Laboratory
9. Decontamination Trailer
10. Motor Control Center
11. Control Room

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Alberta Taciuk Process

11-Dec-97

Project: Pacific Place Site **Year: 93**

Location: Vancouver, British Columbia Pilot Scale

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): 3.5 Amount Treated (Tonne): 50

Treatment Cost (US$):

Setup Time (days): 15 Breakdown Time (days): 10

Media Treated: Soil

Contaminants Treated: PAH's; Chlorophenols; Oil and Grease

Emissions/ByProducts:

Description: Four separate tests averaging about four hours in length were performed using UMATAC's 5-tonne-per-hour prototype unit. Feed rates ranged from 2.7 to 4.1 tonnes per hour. During each test run, samples of the feed and samples of the treated tailings (treated soils, baghouse ash, and cyclone ash) were collected every 30 minutes. Composite samples of both water and oil were also collected from each run every 30 minutes and analysed. The ATP achieved nearly 100% removal of organic contaminants from the soil and demonstrated that treated soils met the treatment goals for organic contaminants. Destruction and removal efficiencies for PAH's ranging from 98.41 to 100.00% were calculated by the vendor.

Project: Waukegan Harbor Superfund Site **Year: 92**

Location: Waukegan Harbor, Illinois Full Scale Demo

Client/Funding Agency	Contact	Phone
Superfund/US EPA	Cindy Nolan, US EPA	

Not Audited

Feed Rate (Tonne/hr): 10 Amount Treated (Tonne): 13000

Treatment Cost (US$):

Setup Time (days): 15 Breakdown Time (days): 10

Media Treated: Soil & Sediment

Contaminants Treated: PCB's, Dioxins, Furans, Particulates, Hydrogen Chloride, Sulfur Dioxide, Hydrocarbons

Emissions/ByProducts:

Description: Located on the western shores of Lake Michigan, portions of Waukegan Harbor and an adjacent stream were found to have been affected by high levels of PCB's. Concentrations in soils and sediments in some areas exceeded 23,000 ppm. Working within Canonie Environmental's final remediation plan, the SoilTech ATP 10TPH system was mobilized to the site in Dec. 1991 and successfully completed its portion of the project in early July 1992. After completing an extensive 30-day "proof-of-process" period, operations of the SoilTech ATP 10TPH system outperformed initial projections by achieving average operating rates of 10 tons-per-hour and mechanical availability of 85%. At the conclusion of operations, the ATP system had desorbed 30,000 gal. of PCB oil from nearly 13,000 tons of soils and sediments.

Project: Hamilton Harbour Sediments **Year: 91**

Location: Hamilton, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. 20 litre sample from Hamilton Harbour "hot spot". Liquid slurries with concentrations of water of 60 wt.%. Free water after settling was 33% by volume. Treatability studies were run on homogenized mixure as received.

Contaminants Treated: TOC, Oil & Grease, PAH. See Table.

Emissions/ByProducts: The ATP produces a medium strength waste water product from treating these sediments. The quantities were quite large due to the high moisture level in the feed. Scondary treatment of water will be an important part of the treatment facility.

Description: The treatability studies were performed at the UMATAC facilities in Calgary, Alberta. Two batch units were used, simulating the retort zone and the combustion zone of the process. A batch pyrolysis unit tested for distillation and pyrolytic extraction of organics, the processes relevent to the retort zone of the ATP. The batch combustion unit, which is similar in design to the pyrolysis unit (the main difference is that combustion air is added to the combustion unit) was used

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to test one solids sample from a pyrolysis test of each sediment. The sample was added and run until extinction of the coke. The test was to ascertain the combustion characteristics of the coked solids, the major requirements of a flue gas treatment system in a pilot/full scale ATP unit and the physical and environmental characteristics of the combusted solids.

RESULTS
The combination of pyrolysis and combustion were effective in substantially reducing the organic contaminant concentrations. The pyrolysis stage separated more than 90% of the oil and grease from the solids, which was reflected in the reduced levels of organic contaminants in the treated solids and high BOD and COD values of the liquid effluent sttream (primarily water). The water condensed from the pyrolysis unit would require treatment prior to discharge. Oil was condensed in significant quantities (50L/tonne of raw sediment). PAHs were reduced to non-detect limits for the coked solids and concentrated in the liquid stream.
After combustion, both the oil and grease and the Total Organic Carbon had been reduced by over 99%. The resulting solids remained contaminated to a significant degree by metals only. However, the metal leachate values obtained for the combusted solids were all lower than regulatory limits.

	Initial Concentrations (mg/kg dry wt.)			Destruction and Removal Efficiency (%)		
Test	TOC	O&G	PAH	TOC	O&G	PAH
Pyrolysis	3460	134		13.3	95.8	
Pyrolysis	3455	134	115	76.9	92	>93.4
Pyrolysis	3460	134		16.2	>96.3	
Combustion				64.2	94.3	N/D

Project: Thunder Bay Sediments **Year: 91**
Location: Thunder Bay, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	Craig Wardlaw	(905) 336-8913

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. 20 litre sample from Thunder Bay "hot spot". Liquid slurries with concentrations of water of 67 wt.%. Free water after settling was 37% by volume. Treatability studies were run on homogenized mixture as received.

Contaminants Treated: TOC, Oil & Grease, PAH. See Table.

Emissions/ByProducts: The ATP produces a medium strength waste water product from treating these sediments. The quantities were quite large due to the high moisture level in the feed. Scondary treatment of water will be an important part of the treatment facility.

Description: The treatability studies were performed at the UMATAC facilities in Calgary, Alberta. Two batch units were used, simulati

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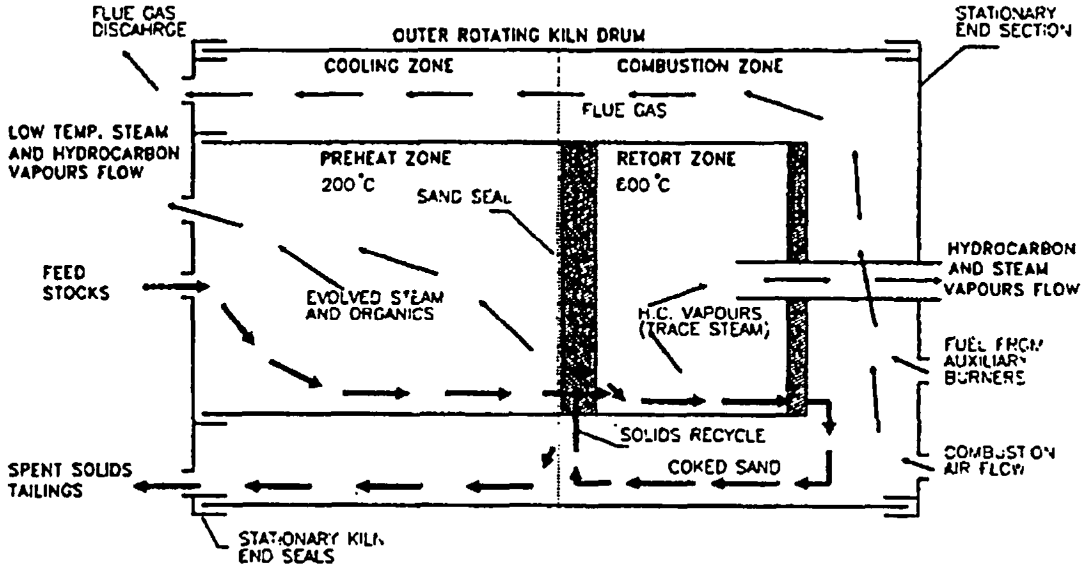
ng the retort zone and the combustion zone of the process. A batch pyrolysis unit tested for distillation and pyrolytic extraction of organics, the processes relevent to the retort zone of the ATP. The batch combustion unit, which is similar in design to the pyrolysis unit (the main difference is that combustion air is added to the combustion unit) was used to test one solids sample from a pyrolysis test of each sediment. The sample was added and run until extinction of the coke. The test was to ascertain the combustion characteristics of the coked solids, the major requirements of a flue gas treatment system in a pilot/full scale ATP unit and the physical and environmental characteristics of the combusted solids.

RESULTS
The combination of pyrolysis and combustion were effective in substantially reducing the organic contaminant concentrations. The pyrolysis stage separated more than 90% of the oil and grease from the solids, which was reflected in the reduced levels of organic contaminants in the treated solids and high BOD and COD values of the liquid effluent sttream (primarily water). The water condensed from the pyrolysis unit would require treatment prior to discharge. PAHs were reduced to non-detect limits for the coked solids and concentrated in the liquid stream.
After combustion, both the oil and grease and the Total Organic Carbon had been reduced by over 94%. The resulting solids remained contaminated to a significant degree by metals only. However, the metal leachate values obtained for the combusted solids were all lower than regulatory limits.



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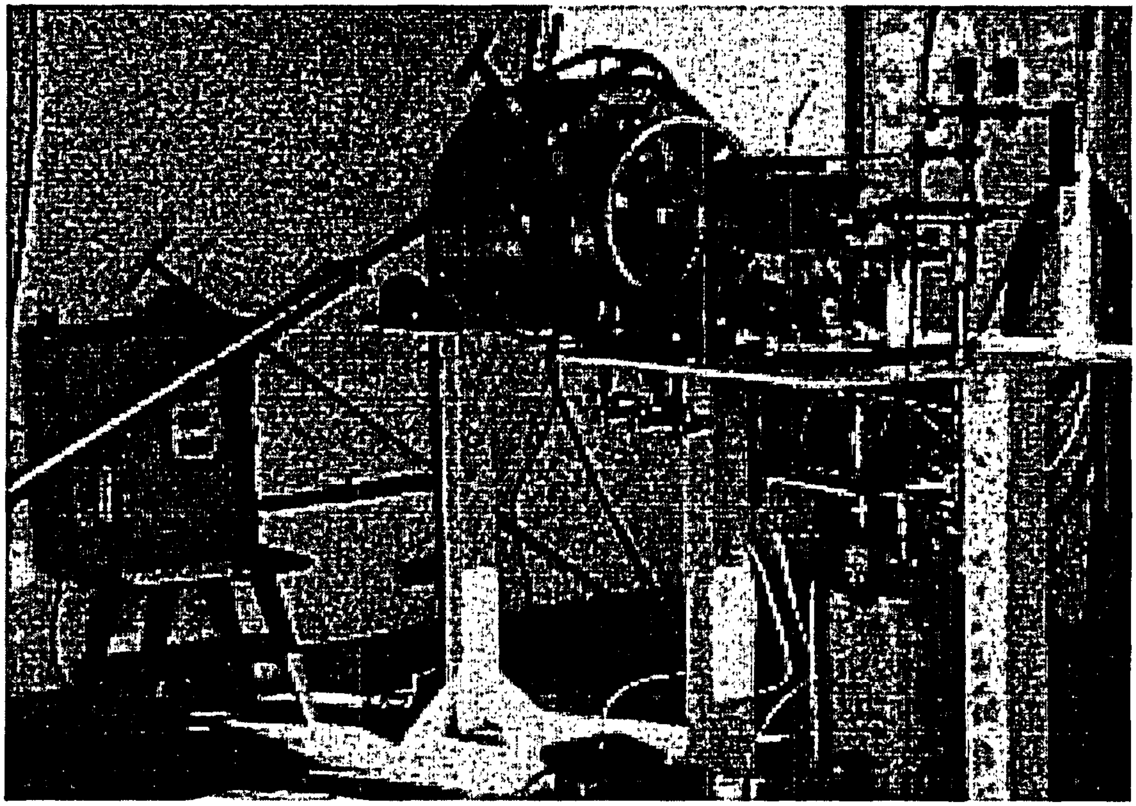
	Initial Concentrations (mg/kg dry wt.)			Destruction and Removal Efficiency (%)		
Test	TOC	O&G	PAH	TOC	O&G	PAH
Pyrolysis	11350	3340	115	55.9	>99.9	
Pyrolysis	11270	3315	2180	96.5	>99.8	>99.6
Pyrolysis	11380	3345		72.8	99.8	
Combustion				>99.1	99.7	N/D



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ALTECH Technology Systems Ltd., Bioremediation (INACTIVE)

11-Dec-97

Technology Type: Biological

TechID: 4

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Inactive **Country Of Origin:** Canada **Portable:** ☐

Description:

Few studies have been performed on the bioactivity of underwater sediments. Questions such as how much dissolved oxygen may be getting to the bacteria, whether the sediments are over saturated with water thereby inhibiting bioremediation, and the size and characteristics of the bacteria colony itself play a major role with the potential for bioactivity. It is suggested that the sediment be removed and treated on land or in a bioreactor. Time and research are required to test the feasibility of a sediment bioremediation project.

Limitations:

Efficiency Description: >99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide and water

Developers:

ALTECH Technology Systems Inc.
225 Sheppard Ave. W.
North York, Ontario
Canada M2N 1N2
Notes

Contact: Keen, Alex
Phone: (416) 226-0148 Ext:
Fax: (416) 226-2931
Email:

Literature References:

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ALTECH Technology Systems Ltd., Soil Washing

11-Dec-97

Technology Type: Chemical, Metal Extraction, Organic Extraction, Physical, Soil Washing/Volume Reduction — TechID: 5

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The ALTECH soil washing process is designed to treat soil and sediment contaminated with chlorinated and non-chlorinated hydrocarbons, as well as metals.

The ALTECH soil washing system works by attrition scrubbing of soil/sediment with proprietary chemical addition to enhance the release of the contaminant from the soil. The contaminant is held to the soil particle by weak ionic bonds that are broken through the combination of chemistry and shear energy.

The process is continuous with a rated capacity of 40 tons per hour. The equipment is a series of scrubbers, cyclones, and separators.

Patents apply to the overall process and the innovative separation processes for fines. Wastewater treatment is tailored to the contaminant being treated.

Limitations: Organics treatment more effective than metals. Organics removal 95-98% efficient; metals, 60-70% efficient. May need two passes depending on inlet concentration.

Efficiency Description: Have achieved 95%-100% removal of contaminants from soil.

Government Funding: Great Lakes Cleanup Fund, GASReP

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Pending

Setup/Feed: Setup Time (days): 4 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 40

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $45.00 – $65.00 Average Cost (US$/Tonne): $50.00

Assuming 10,000 tonnes. Contaminant: copper. Cost can vary based on equipment required for watewater treatment.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Wastewater requiring treatment.

Developers:

ALTECH Technology Systems Inc.
225 Sheppard Ave. W.
North York, Ontario
Canada M2N 1N2
Notes

Contact: Keen, Alex
Phone: (416) 226-0148 Ext:
Fax: (416) 226-2931
Email:

Vendors:

Clean Soils Ltd.
225 Sheppard Ave. West
North York, Ontario
Canada M2N1N2
Notes

Contact: Keen, Alex
Phone: (416) 226-3838 Ext:
Fax: (416) 226-2931
Email:

Clean Soils Ltd.
225 Sheppard Ave., W.
North York, ON
Canada M2N1N2
Notes This vendor serves Canada and Great Lakes region of USA.

Contact: Weis, Gordon M.
Phone: (416) 226-3838 Ext:
Fax: (416) 226-2931
Email:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Alternative Remedial Technologies Inc., Soil Washing

11-Dec-97

TechID: 200

Technology Type: Soil Washing/Volume Reduction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Mercury, Halogenated Organics, Explosives, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

ART and its parent companies Geraghty & Miller, Inc. and Heidemij N.V. perform sediment investigations, characterization and remediation. This capability has been developed over the past several years in conjunction with Heidemij subsidiaries Serasea and Konijn. Techniques such as Gamma Isotope Mapping and continuous Seafloor Sediment sampling for determining sediments requiring removal, the "Fingerprint" method for characterization of sediments, and traditional soil washing processes for sediments remediation are utilized. Through these methods, a full range of sediments services are offered by the company.

The ART soil washing process is a physical-chemical approach based on mining and mineral processing principles. For environmental/hazardous waste applications, this approach is very logical since the contaminants of concern will exist in specific particle fractions in reasonably predictable ways.

To understand whether a particular contaminated soil is amenable to soil washing, ART will collect representative samples from the site, perform the wet sieving size classification, and construct the particle-size distribution curve. This information, coupled with existing site background information, will provide significant insight into the possible treatment scenarios, and thus the configuration of a soil washing system.

The ART performance objectives are to manage the entire volume of contaminated soil at the site. Oversize materials will be removed by various mechanical techniques, and the sand separated from the fines using hydrocyclone combinations. The sand is then treated, as necessary, with attritioners, flotation, and spiral concentrators, prior to dewatering. The oversize and the sand fractions will be sampled and analyzed according to site-specific protocols, and after attainment of the treatment standards is confirmed, returned to the site as clean backfill. Concurrently, the fines will be consolidated, and either dewatered into a sludge cake, or further treated using bioslurry or extraction methods.

The performance of a soil washing system will typically be measured by the volume reduciton attained and by the clean products (the oversize and the sand) meeting the specified cleanup standards.

The ART soil washing system is constructed completely of standard mining and material handling equipment. ART owns a 15 tons per hour pilot plant and a 25 tons per hour production plant. Both plants are modular, and are therefore easily transported and erected. The pilot plant has a "footprint" of approximately 30' x 50' while the full-scale plant has a corresponding footprint of approximately 60' x 100'. In both cases, these dimensions do not include the process feed pile or the product staging areas.

The ART approach to soil washing is simple: separate and treat the oversize and sand fractions so that they may be placed back on the site as clean backfill, while concentrating the contaminants in the fines for further treatment or disposal. To accomplish this, the ART plants (both pilot and full-scale) consist of four major subsystems:

a) Mechanical and wet screening
b) Separation using hydrocyclones in circuits
c) Sand handling and treatment
d) Fines handling and treatment
e) Support systems (provided but not shown as a sub-system)

Limitations: This method of treatment is most economically effective on soils that are no more than 30 percent clay or silt and on volumes greater than 5,000 tons. As the proportion of the fine-grained material increases, the waste stream becomes more difficult to process, which adds to the cost.

Efficiency Description: Usually between 90 - 97 %.

Government Funding:

Environmental Concerns: None

Health & Safety Plan Available: ☒

Regulatory Approvals None

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 20

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $85.00 – $195.00 Average Cost (US$/Tonne): $140.00

Costs are dependent upon several criteria, such as volume of sediments to be remediated, percentage of fines, site conditions, etc., and cannot be quoted with any accuracy for a particular contaminant without this data. A "ballpark" range, however, is $85 - $195 per ton.

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Alternative Remedial Technologies Inc., Soil Washing

11-Dec-97

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Contaminated residuals (fines) < 5% of feed volume to contaminated residuals < 10% of feed soil.

Developers:

Heidemij N.V.
Postbus 139
6800 AC Arnhem,
The Netherlands
Notes

Contact: Heddema, Ton
Phone: (813) 264-3571 Ext:
Fax: (8) 543-7386
Email:

Vendors:

Alternative Remedial Technologies Inc.
14497 North Dale Mabry Highway, Suite 140
Tampa, FL
USA 33618-
Notes

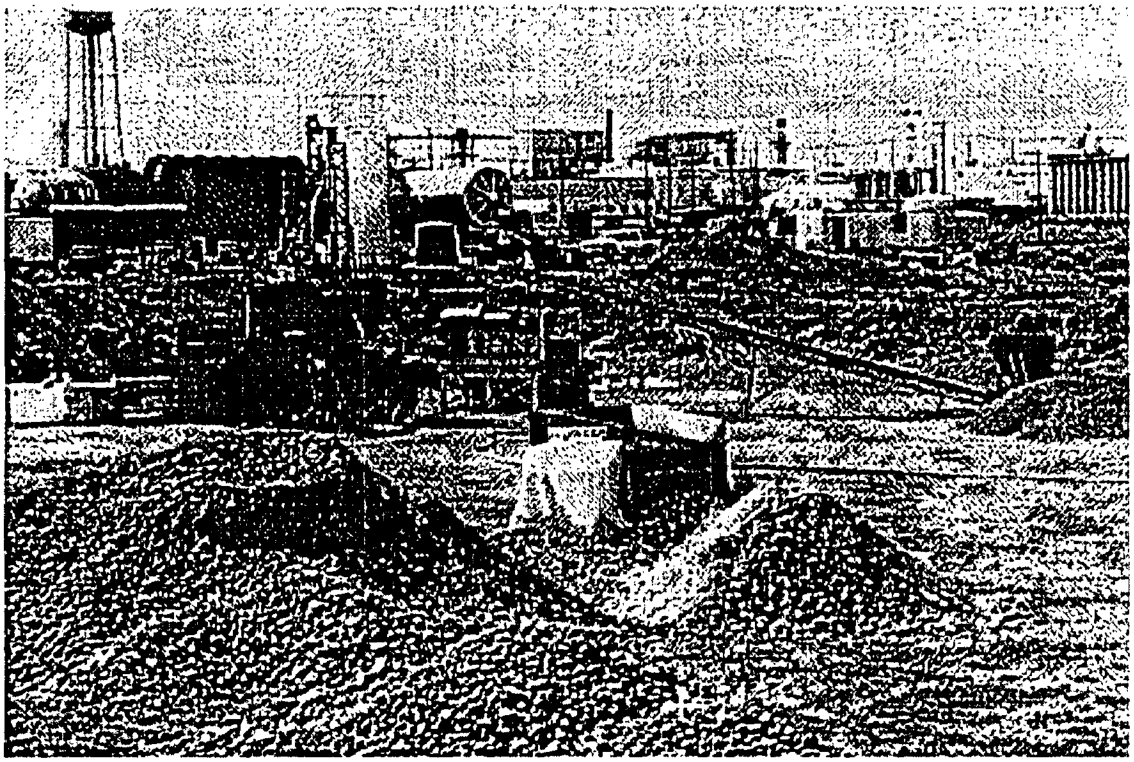
Contact: Mann, Michael J.
Phone: (813) 264-3571 Ext:
Fax: (813) 962-0867
Email:

Literature References:

Author: **Besch, J.**
Title: Soils take a bath at Superfund Site
Journal: Soils
Date: **Nov 1993**

Author: **Besch, J.**
Title: Soil washing at a Superfund Site
Journal: Econ
Date: **Dec 1993**

Author: **US EPA/OSWER/TIO**
Title: Remediation Case Studies: Thermal desorption, soil washing , and in situ vitrification. EPA/542-R-95-005. Prepared by the
Journal: Member Agencies of the Federal Remediation Technologies Roundtable.
Date: **Mar 1995**



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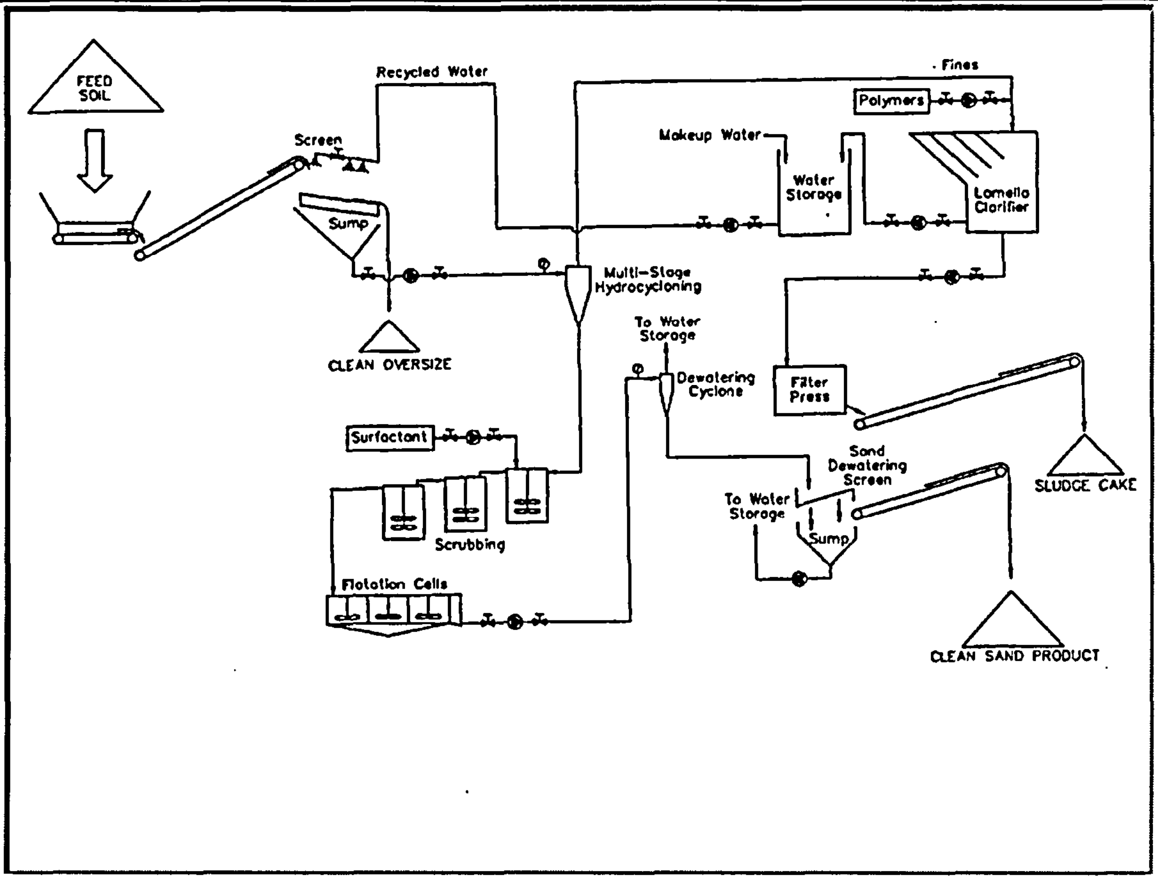
Alternative Remedial Technologies Inc., Soil Washing

11-Dec-97



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Project: The Hanford Site **Year: 94**

Location: Richland, Wa Pilot Scale

Client/Funding Agency	Contact	Phone
US DOE	Ms. Jhivaun Freeman-Pollard	(509) 372-9347

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 380

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Copper, Uranium-238, Uranium-235, Cesium-137, Cobalt-60

Emissions/ByProducts:

Description: The soil washing pilot plant was located in the 300 Operable Unit at the DOE Hanford Site, WA. Soils from two areas in the OU were processed, (1) 300 tons containing metals, organic materials, and low-level uranium and (2) 80 tons of soil containing elevated levels of copper and uranium. The test was conducted in three stages (1) pre-test run (2) verification run and (3) replication run. The plant consisted on a feed hopper, double-decked wet screen, hydrocyclones, attrition scrubber, sand dewatering screen, sludge thickening and dewatering units and supporting peripheral equipment.

Project: Merck & Co., Inc. **Year: 94**

Location: Hawthorne, NJ Bench Scale

Client/Funding Agency	Contact	Phone
None	Mr. Ned Speizer	(908) 302-7283

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Mercury, Lead, Arsenic, Copper, Zinc, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Indeno(1,2,3-c,d)pyrene, Dieldrin, PCB's.

Emissions/ByProducts:

Description: Two representative soil samples, approximately 100 kg each, were collected from the site through excavation of multiple test pits and the following bench-scale tests conducted: chemical analysis, characterization with respect to particle-size distribution, chemical analysis of the fractions, testing of proposed treatment processes, design of PFD and cost estimate for full-scale remediation.

Project: Camp Pendleton (Site 3) **Year: 94**

Location: MCB Camp Pendleton, CA Bench Scale

Client/Funding Agency	Contact	Phone
US Navy	Mr. Edward Dias	(619) 532-3575

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: 4,4-DDE, 4,4-DDD, 4,4-DDT, Dieldrin, Pyrene, Benzo(a)anthracene, TPH, Arsenic

Emissions/ByProducts:

Description: Soils from two sites at Camp Pendleton (Site 3 and Site 6 - see next project) were evaluated for their applicability to soil washing. Site 3 is an old pest control wash rack operated from the 1950's until 1980 with about 19,600 cy of soil to be remediated.

Project: Camp Pendleton (Site 6) **Year: 94**

Location: MCB Camp Pendleton Bench Scale

Client/Funding Agency	Contact	Phone
US Navy	Mr. Edward Dias	(619) 532-3575

Not Audited

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Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: 4,4-DDE, 4,4-DDD, 4,4-DDT, Dieldrin, PCB's

Emissions/ByProducts:

Description: Soils from two sites at Camp Pendleton (Site 3 and Site 6 - see previous project) were evaluated for their applicability to soil washing. Site 6 is an old scrapyard which received scrap metal, hazardous materials, and transformer fluids from the 1950's until 1979.

Project: King of Prussia Technical Corporation Site **Year: 93**

Location: Winslow Township, NJ Full Scale Demo

Client/Funding Agency	Contact	Phone
KOP PRP Cooperating Group	Frank J. Opet	(609) 384-7222

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 19200

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Copper, Nickel, Chromium

Emissions/ByProducts:

Description: The soil washing plant was made up of screening, separation, coarse treatment, fines treatment, and residuals concentration units. 19,200 tons were treated from June 1993 - October 1993. Contaminated fines were consolidated and disposed as non-hazardous waste at a landfill. Clean sand and oversize were returned to the site as backfill.

Project: The Hague **Year: 92**

Location: The Hague, the Netherlands Full Scale Demo

Client/Funding Agency	Contact	Phone
SCG	Mr. K. Berghuis	030-899499

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PNA's

Emissions/ByProducts:

Description: Treatability studies and bench-scale studies were conducted prior to full-scale remediation. The studies indicated use of a treatment train consisting of soil washing and thermal treatment. In the full-scale operation, soil washing was used to make the initial volume reduction and clean the sand fraction, and thermal treament was used to destroy the PNA's on the oversize.

Project: Ter Apel **Year: 91**

Location: City of Groningen, The Netherl Full Scale Demo

Client/Funding Agency	Contact	Phone
City of Groningen, The Netherlands	Mr. F.X. Widman	050-673324

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Arsenic, Chromium

Emissions/ByProducts:

Description: Soils were from a former wood preserving facility that used chromium and arsenic salts as a preservative. Spillage had resu

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lted in contamination up to a depth of 24 feet. Due to the high mobility of the contaminants and the threat to groundwater, remediation was completed on a "fast track" basis. This achieved considerable cost savings to the client and prevented the spread of the contaminants to the groundwater.

Project: Gaslaan **Year: 83**

Location: Province of Zuid, Holland

Full Scale Demo

Client/Funding Agency	Contact	Phone
not available	not available	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated: Lead, Zinc, Cyanide, PNA's, Mineral oil

Emissions/ByProducts:

Description: This was the first full-scale soil washing project in The Netherlands and the first Heidemij soil washing project. ART's parent company pioneered development of the technology and fabrication of the equipment. Studies and experiments conducted prior to full-scale soil washing included treatability studies, bench-scale studies, and a pilot study. As a result of this project the Dutch "A" "B" and "C" soil remediation levels were developed.
Treatment Cost : Phase I - $1,650,000 ; Phase II - 3,170,000 ; Phase III - not available.
Overall removal eficiency : 97%.

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American Combustion Pyretron Oxygen Burner

11-Dec-97

TechID: 155

Technology Type: Incineration

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☐

Description:

The Pyretron Oxygen Burner controls the heat input and level of excess oxygen available in an incineration process. The Burner incinerates pure oxygen, combined with air and natural gas to provide increased incineration and mixing rates resulting in a greater throughput than more conventional units. At the same time, the Burners may be fitted onto any incineration unit designed for burning solids, liquids, and sludges to increase the throughput. This application can result in cost savings in many circumstances.

The process treats high and low BTU wastes and is computer controlled to automatically adjust the temperatures of the primary and secondary chambers and the amount of excess oxygen depending on the waste being incinerated.

Limitations:

Efficiency Description: >99.99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Accepted into the U.S. EPA SITE Demonstration Program

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: not applicable

Developers:

American Combustion
4476 Park Drive
Norcross, GA
USA 30093-
Notes

Contact: Gitman, Gregory
Phone: (404) 564-4180 Ext:
Fax: (404) 564-4192
Email:

Literature References:

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ARC Sonics, Sonically Enhanced Oxidation/Metals Extraction

11-Dec-97

TechID: 102

Technology Type: Physical, Soil Washing/Volume Reduction

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☒

Description:

The 12 tonne unit will slurry 100 to 500 tonnes of clay per day. The unit can be loaded on a low-bed truck for transportation and can be set up in about 3 days.

The technology is low frequency (100-500 Hz) high power (20 kW to 75 kW). The sonic energy will open up the clay or silt matrix.

Limitations: Ex-situ; slurry, not a dry process.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns: Slurried clays must be stabilized before return to the environment.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 4

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $200.00

The sonic equipment would have to be part of a complete treatment system. It is uniquely capable of slurrying clays and silts. Sonically enhanced oxidation has proved very effective in distruction or organic and organo-chloride contaminants. With metals, the degree of fixation achieved was extremely high.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

ARC Sonics, Inc.
Box 24, Ste. 722 - 601 West Broadway
Vancouver, BC
Canada V5Z4C2
Notes

Contact: Russell, John
Phone: (604) 876-5005 Ext:
Fax: (604) 876-5004
Email: 103762.3507@comp

Vendors:

ARC Sonics, Inc.
Box 24, Ste. 722 - 601 West Broadway
Vancouver, BC
Canada V5Z4C2
Notes

Contact: Russell, John
Phone: (604) 876-5005 Ext:
Fax: (604) 876-5004
Email: 103762.3507@comp

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

ARC Sonics, Sonically Enhanced Oxidation/Metals Extraction

11-Dec-97

Project: Integration of Enhanced Oxidation ...

Year: 93

Location: Burnaby, BC, Canada

Bench Scale

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Clay

Contaminants Treated: PCP
PCE
Xylene

Emissions/ByProducts:

Description: An extended series of batches was treated.

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ART International Inc., Low-Energy Solvent Extraction Process (LEEP)

11-Dec-97

TechID: 117

Technology Type: Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

LEEP, a physical separation process, uses organic solvents to extract and concentrate organic pollutants from solids. After a pretreatment step, the solid matrix is washed with a combination of carefully selected hydrophilic and hydrophobic solvents The extracted pollutants are subsequently concentrated for return to commerce or off-site disposal. The decontaminated solids can be safely returned to the environment. The process is designed as a self-contained system with internal recycling of the leaching solvents.

The development of the LEEP technology to date has resulted in two commercial plant designs: a LEEP plant aimed at coal tars and related compounds, and a LEEP plant aimed at PCB's and related compounds.

The two plants shown in the conceptual block diagram have similar process configurations and are designed as closed-loop systems capable of handling solids with high water content and particle sizes of up to 20 cm in diameter.

After excavation and removal of debris, the solids are fed to the process through a combination of grizzly/vibrating screens to remove oversized (>20 cm) material. After removal of ferrous and nonferrous metals, the solids are crushed to the desired size. If the original solid matrix contains free water (e.g. dredged sediments), the material is separated, by filtration or centrifugation, into a solid and a liquid fraction. The liquid is treated in LEEP's integrated activated carbon water purification system.

The solids are fed to a leaching operation which is performed at atmospheric pressure in a continuous solid/liquid countercurrent contactor. The leaching solvent in the LEEP-Tar plant is acetone and a proprietary hydrophobic solvent. In the LEEP-PCB plant, this is accomplished by liquid-liquid extraction using kerosene and distillation. The leaching solvents are internally recycled. PCB-laden kerosene is collected for off-site disposal, and refined coal tars or related compounds are collected and can be returned to commerce.

The recovered water, which is leached from the contaminated solids, is treated in LEEP's water purification system. The residual solvents associated with the leached soil are removed in a continuous dryer and are internally recycled.

Treated to regulatory requirements, the solids and water are recombined in the last process step. The clean moist solids are discharged from the process and can be returned to the environment after certification.

Limitations: Metals cannot be treated ex-situ.

Efficiency Description: >99.99%

Government Funding: ARCS, SITE

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals TSCA, RCRA, AIR, in New Jersey USA

Setup/Feed: Setup Time (days): 40 Breakdown Time (days): 20

Feed Rate Average (Tonne/hr): 155

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $15.00 – $60.00 Average Cost (US$/Tonne): $35.00

Unit costs include Mobilization/Demobilization, ALL operating costs, cost of capital, QA/QC, Site Management. Analytical Moisture content of sediment: 50%.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products:

Developers:

ART International, Inc.
100 Ford Road
Denville, NJ
USA 07834-

Contact: Steiner, Werner
Phone: (201) 627-7601 Ext:
Fax: (201) 627-6524
Email:

Notes

Vendors:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

ART International Inc., Low-Energy Solvent Extraction Process (LEEP) *11-Dec-97*

ART International, Inc.
100 Ford Road
Denville, NJ
USA 07834-
Notes

Contact: Steiner, Werner
Phone: (201) 627-7601 Ext:
Fax: (201) 627-6524
Email:

Environmental Science & Engineering
5205 Militia Hill Rd.
Plymouth Meeting, PA
USA 19462-
Notes

Contact: Kamps, Charlie
Phone: (610) 941-9700 Ext:
Fax: (610) 941-9707
Email:

Literature References:

Author: **Carpenter, B., Wilson, D.**
Title: PCB Sediment Decontamination Processes Selection for Test and Evaluation
Journal: Hazardous Waste & Hazardous Materials, Vol. 5, No. 30 Date: **Jan 1988**

Author: **Hall, D., et al**
Title: An Overview of Solvent Extraction Treatment Technology
Journal: Environmental Progress Date: **May 1990**

Author:
Title: Engineering Bulletin-Solvent Extraction Treatment
Journal: EPA Bulletin 540/2-90/013 Date: **Sep 1990**

Author:
Title: Firm Developing Solvent Extraction Processes for Organics, Inorganics
Journal: Haztech News, Vol. 6, No.1 Date: **Jan 1991**

Author: **Steiner, W.**
Title: New Technologies Offer Site Clean-Up Alternatives
Journal: Civil Engineering News Date: **Sep 1991**

Author: **Steiner, W., Rugg, B.**
Title: LEEP Low Energy Extraction Process for On-Site Remediation of Soils, Sediment and Sludges
Journal: 85th Annual Meeting & Exposition of the Air & Waste Management Association, Kansas City, Kansas, USA Date: **Jun 1992**

Author: **Steiner, W., Rugg, B.**
Title: LEEP Commercialization Activities - Treatment of Tar Contaminated Soil from Manufactured Gas Plant Sites
Journal: PCB Forum, Doubletree Hotel, Houston, Texas, USA Date: **Mar 1993**

Author: **Steiner, W.**
Title: Solvent Extracts Coal Tars, PCBs - New Mobile Plant Process Relies on Leaching
Journal: Soils Date: **Oct 1994**

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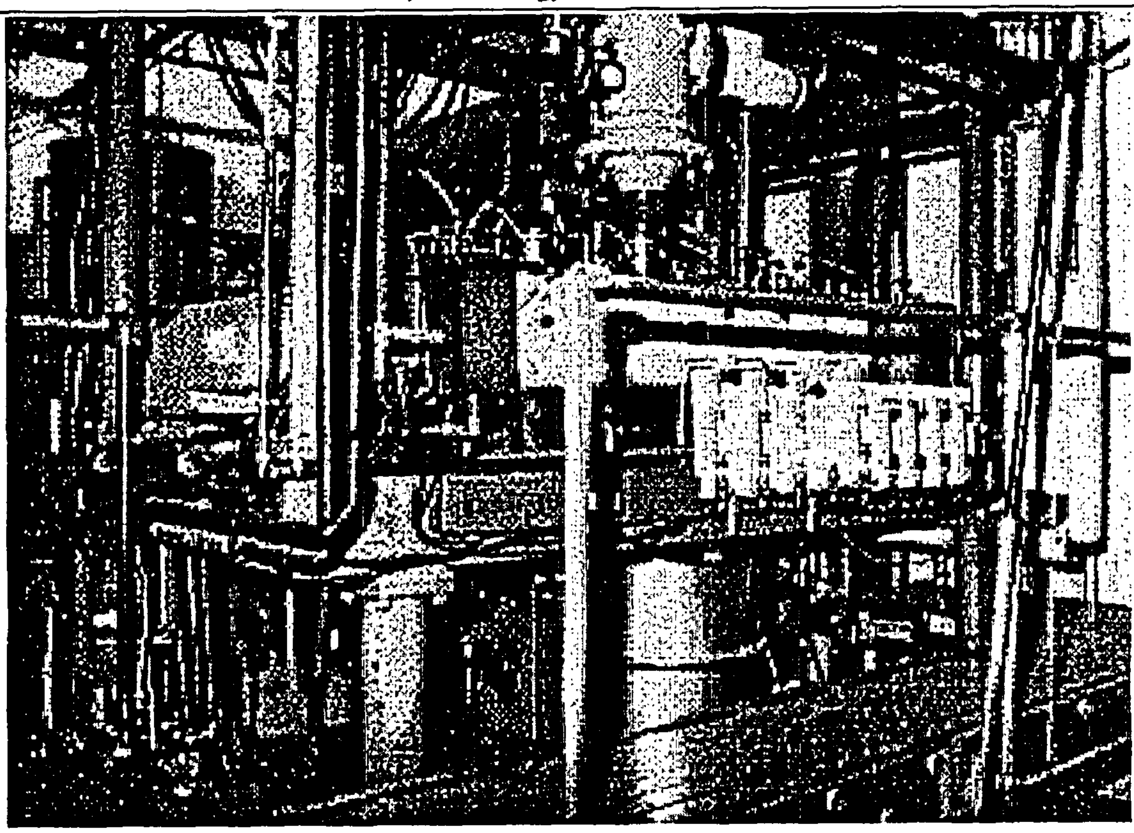
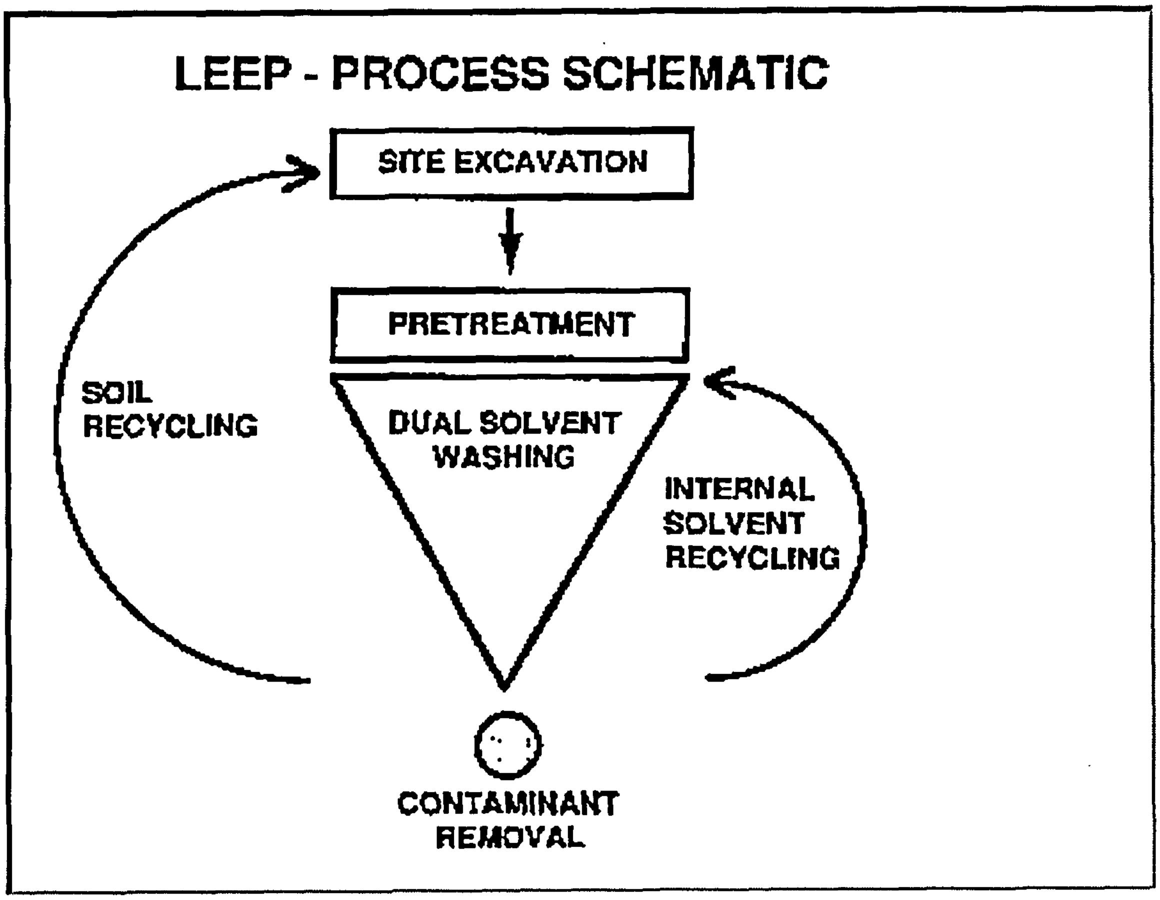
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.





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ART International Inc., Low-Energy Solvent Extraction Process (LEEP)

11-Dec-97

Project: W.E. TS — **Year: 93**

Location: West End, New Jersey, USA — Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne): 0.0022675

Treatment Cost (US$):

Setup Time (days):
Breakdown Time (days):

Media Treated: Sandy Loam

Contaminants Treated:

	Untreated:	Treated:	% Removal:
Coal Tar	25,600 ppm	< 2 ppm	>99.99
PAH's	1104 ppm	< 1 ppm	>99.9

Clean-up Goals: PAH's < 10 ppm

Emissions/ByProducts:

Description: Treatability study for client

Project: PAT TS-2 — **Year: 92**

Location: Patterson, New Jersey, USA — Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne): 0.004535

Treatment Cost (US$):

Setup Time (days):
Breakdown Time (days):

Media Treated:

Contaminants Treated:

	Untreated:	Treated:	% Removal
Coal Tar	63,000 ppm	< 10 ppm	> 99.98
PAH's	3128 ppm	< 8 ppm	> 99.7

Clean-up Goals: PAH's < 10 ppm

Emissions/ByProducts:

Description: Treatability study for client

Project: PAT PP-2 — **Year: 92**

Location: Patterson, New Jersey, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Clean Soil Technologies	Werner Steiner	(201) 627-7601

Not Audited

Feed Rate (Tonne/hr): 0.0907
Amount Treated (Tonne): 0.2721

Treatment Cost (US$):

Setup Time (days):
Breakdown Time (days):

Media Treated: Sandy Loam

Contaminants Treated:

	Untreated:	Treated:	% Removal
Coal Tar	750 ppm	240 ppm	> 68
PAH's	190 ppm	4 ppm	> 97.9

Clean-up Goals: PAH's < 10 ppm

Emissions/ByProducts:

Description: Pilot plant test run as part of broader development effort for Clean Soil Technologies.

Project: PAT PP-4 — **Year: 92**

Location: Patterson, New Jersey, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Clean Soil Technologies	Werner Steiner	(201) 627-7601

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Not Audited

Feed Rate (Tonne/hr): 0.0907 Amount Treated (Tonne): 0.3628

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sandy Loam

Contaminants Treated:

	Untreated:	Treated:	% Removal
Coal Tar	60,000 ppm	32 ppm	> 99.9
PAH	2,500 ppm	6 ppm	> 99.8

Clean-up Goals: PAH's < 10 ppm

Emissions/ByProducts:

Description: Pilot plant develoment tests for Clean Soil Technologies.

Project: PAT TS-1 **Year: 91**

Location: Patterson, New Jersey, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.0022675

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sandy Loam

Contaminants Treated:

	Untreated:	Treated:	% Removal
Coal Tars	700 ppm	< 10 ppm	>98.5
PAH's	190 ppm	< 1 ppm	>99.5

Clean-up Goals: PAH's < 10 ppm

Emissions/ByProducts:

Description: Treatability study for client.

Project: ERUTH TS **Year: 91**

Location: Erutherford, New Jersey, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.0022675

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sandy Loam

Contaminants Treated:

	Untreated:	Treated:	% Removal
PCB's	38108 ppm	< 1 ppm	> 99.97

Clean-up Goals: PCB's < 5 ppm

Emissions/ByProducts:

Description: Treatability study for client

Project: PITTSF TS **Year: 90**

Location: Pittsfield, Massachusetts, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.004535

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

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Media Treated: Silt Loam

Contaminants Treated:		Untreated:	Treated:	% Removal
	PCB	10,600 ppm	<5 ppm	>99.95
	PAH	469 ppm	<1 ppm	>99.8

Clean-up Goals: PAH < 10 ppm; PCB < 5 ppm

Emissions/ByProducts:

Description: Treatability study to test LEEP's applicability at client's site.

Project: OAKL TS **Year: 90**

Location: Oakland, California, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.000907

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Silt Loam

Contaminants Treated:		Untreated:	Treated:	% Removal
	PCB's	2463 ppm	< 1 ppm	> 99.9

Clean-up Goals: PCB's < 5 ppm

Emissions/ByProducts:

Description: Treatability study

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Ashwarren Hydrocarbon Recycler

11-Dec-97

TechID: 16

Technology Type: Thermal

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

Studies to utilize and recycle hydrocarbons for further use, rather than destroy them, has been underway for two years. Remediated solids are recycled into one of three pre-selected products: asphalt concrete, road base material, or engineered fill material. The process is designed to accept refined petroleum contaminated soils and to work with TPH's up to 30 000 ppm.

Limitations:

Efficiency Description: Recycles hydrocarbons

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Ashwarren International Inc.
72 Ashwarren Rd.
Downsview, ON
Canada M3J1Z6
Notes

Contact: Rivett, Mark
Phone: (416) 633-9670 Ext:
Fax:
Email:

Vendors:

Ashwarren International Inc.
1398 Cartwright St., Granville Isl.
Vancouver, B.C.
Canada V6J 4N1
Notes

Contact: McDowell, T.
Phone: (604) 684-5111 Ext:
Fax: (604) 683-2331
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ashwarren Metal Encapsulation

11-Dec-97

TechID: 17

Technology Type: Stabilization/Fixation

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☐

Description:

A patented system of encapsulating metals has demonstrated in preliminary tests to lower soil lead levels from the 115.0 ppm to 153.0 ppm range down to the 3.2 ppm to 6.45 ppm range respectively. Test strips of pavement are being placed this spring for further evaluation.

Limitations:

Efficiency Description: Lead levels reduced from approximately 100 ppm to approximately 5 ppm.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Testing approved by G.V.R.D.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Ashwarren International Inc.
72 Ashwarren Rd.
Downsview, ON
Canada M3J1Z6
Notes

Contact: Rivett, Mark
Phone: (416) 633-9670 Ext:
Fax:
Email:

Vendors:

Ashwarren International Inc.
1398 Cartwright St., Granville Isl.
Vancouver, B.C.
Canada V6J 4N1
Notes

Contact: McDowell, T.
Phone: (604) 684-5111 Ext:
Fax: (604) 683-2331
Email:

Literature References:

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Astec (SPI Division), Thermal Desorption

11-Dec-97

Technology Type: Thermal, Incineration, Stabilization/Fixation, Organic Extraction, Post Treatment, Pre Treatment   TechID: 84

Contaminants Treated: PAH's, Oil & Grease

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial   **Country Of Origin:** USA   **Portable:** ☒

Description:

The ASTEC Soil Purification LTTD systems utilize several unique sub-processes which have significant benefits and offer substantial advantages including: 1) Heat exchanger recycles energy back into the system and results in reduced fuel consumption for the process. 2) Municipal sludge is treated by utilizing heat available in treated soils. With specific mixing and residence time, the sludge is sterilized resulting in clean soil with enhanced organic characteristics. 3) Design variation allows for partial and controlled oxidation in the rotary drum for high BTU content soils. 4) Baghouse included as the final phase of gas treatment, following the afterburner, which eliminates the potential for hydrocarbon condensation in the baghouse. This also allows for the processing of soils containing heavier petroleum products due to the high temperatures of the gas stream that is the carrier gas moving the vaporized VOC's from the drum to the afterburner.

Limitations: This technology is effective for materials contaminted with volatile and semivolatile organic compounds. Contaminant concentrations can be a rate-limiting factor. SPI plants have been applied to sites where the maximum concentrations of contaminants in soils is 0-4% by weight (soils of varying concentrations are blended to obtain a uniform concentration which is typically in the 1-2 % range). Some projects require special considerations for processing soils with high contaminant levels. This has been achieved with special sensing and control systems to monitor and control the lower explosive limit (LEL) within the process.

When thermal desorption is utilized for processing soils contaminated with halogenated organics, an acid gas scrubber is included as the final phase of off-gas treatment, following the baghouse.

Thermal desorption alone is not effective for contaminants containing metals/inorganics. ASTEC SPI systems contain pugmill mixers for soil cooling which have also ben used for stabilization by the addition of flyash, portland cement, or soda-ash.

Efficiency Description:

Government Funding: Superfund

Environmental Concerns: Process parameters must be structured for individual project/application. Stack emissions need to be monitored.

Health & Safety Plan Available: ☐

Regulatory Approvals Various state air permits and solid waste permits.

Setup/Feed: Setup Time (days): 7   Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 20

Cost: Capital Cost (US$): $2,100,000.

Treatment Cost (US$/Tonne): –   Average Cost (US$/Tonne):

Unit costs depend on individual project parameters including fuel costs, labor rates, size of project, etc.

Database References: ATTIC ☐   VISITT ☒

Emissions / By-Products: Carbon Dioxide; Water Vapor

Developers:

SPI Astec Division
P.O.B. 72515
Chattanooga, TN
USA   37407-
Notes

Contact: Feltman, Wendell R.
Phone: (706) 861-0069   Ext:
Fax: (706) 861-2051
Email:

Vendors:

SPI Astec Division
P.O.B. 72515
Chattanooga, TN
USA   37407-
Notes

Contact: Feltman, Wendell R.
Phone: (706) 861-0069   Ext:
Fax: (706) 861-2051
Email:

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Astec (SPI Division), Thermal Desorption

11-Dec-97

Enviro Desorption Inc.
Suite 104, 6815 8th Street N.E.
Calgary, Alberta
Canada T2E 7H7

Contact: Charlesworth, D.R.
Phone: (403) 295-6320 Ext:
Fax: (403) 295-0732
Email:

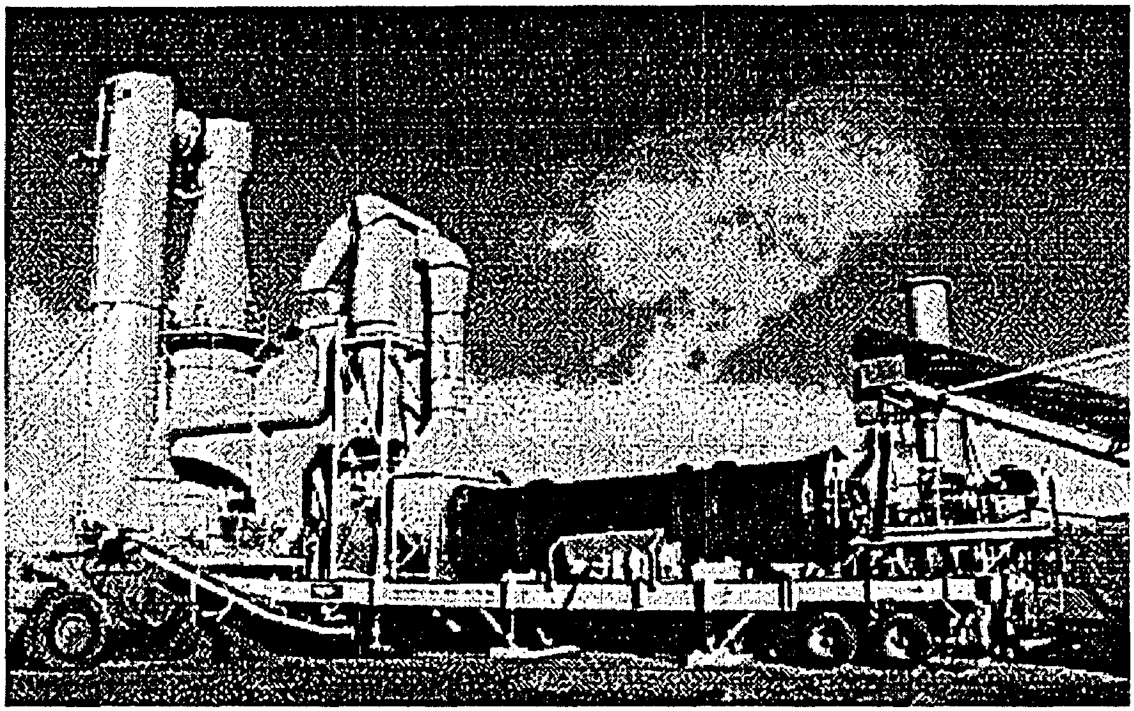
Notes

Literature References:

Author: **Feltman, Wendell R.**
Title: Parallel Flow vs Counterflow Design for Soil Remediation
Journal:
Date: **Oct 1992**

Author: **Feltman, Wendell R.**
Title: Soil Purification Technical Paper T-125
Journal: Astec Industries Library
Date: **Mar 1993**

Author: **Feltman, Wendell R.**
Title: Equipment Design Consideration Used in Thermal Remediation of Contaminated Soils
Journal: Thermal Desorption Technologies Conference
Date: **Nov 1995**



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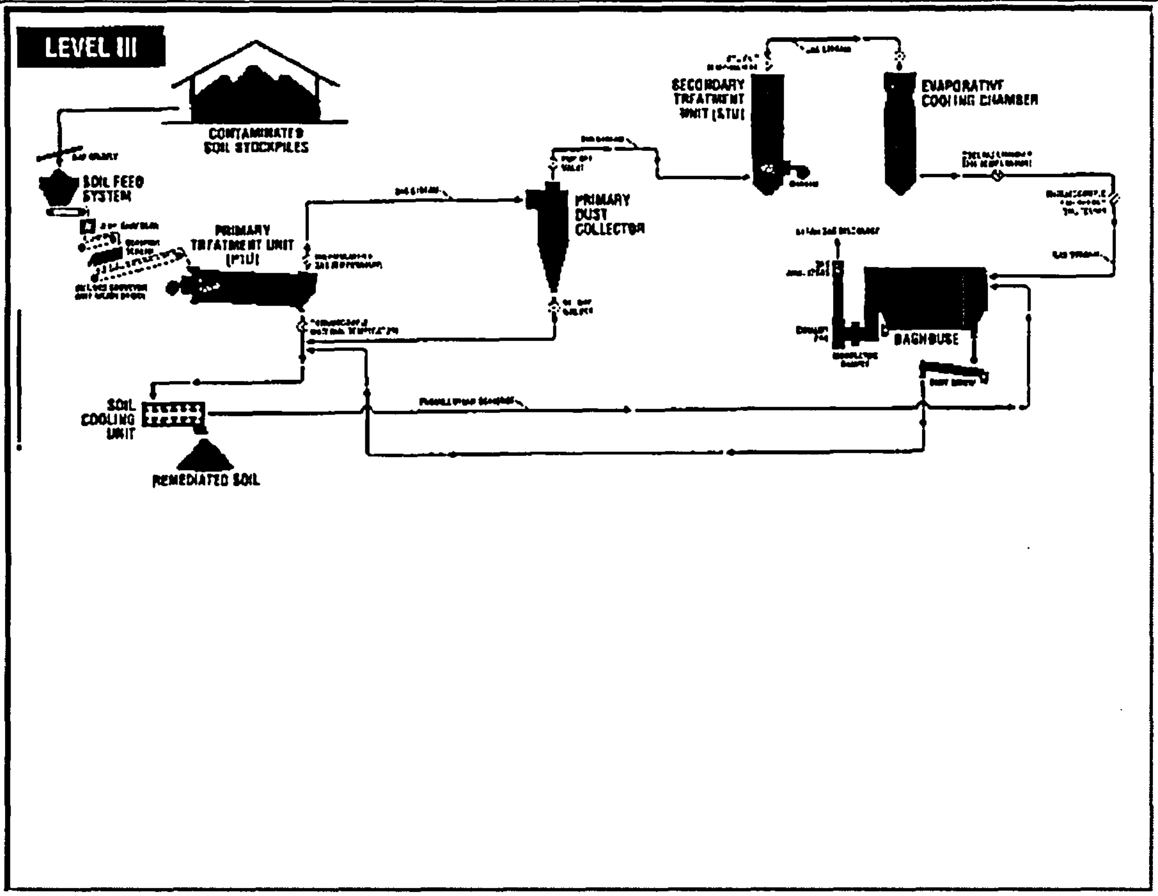
Astec (SPI Division), Thermal Desorption

11-Dec-97



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Astec (SPI Division), Thermal Desorption

11-Dec-97

Project: Southwest Soil Remediation Demonstration **Year: 95**
Location: Tucson, Arizona, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
Private	Trevor Johansen	(520) 571-7174

Not Audited

Feed Rate (Tonne/hr): 24 Amount Treated (Tonne): 23
Treatment Cost (US$):
Setup Time (days): 5 Breakdown Time (days): 4
Media Treated: Contaminated Soils

Contaminants Treated:

	Untreated:	Treated:	% Removal
TPH	2700 ppm	< 20 ppm	
PAH (total)	2845 ppm	< 2.275 ppm	

Cleanup Goals: < 50 ppm TPH and < 1 pm for individual PAH's.

Emissions/ByProducts: Carbon Dioxide; Water Vapor

Description: Demonstration involved existing thermal desorption system used to demonstrate clean-up ability for creosote and Bunker C contaminants. Treatment cost: Confidential.

Project: Plainville Lagoon Bed Residuals **Year: 92**
Location: Plainville, Connecticut, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
Private	Jim Fox	(315) 437-6400

Not Audited

Feed Rate (Tonne/hr): 20 Amount Treated (Tonne): 150000
Treatment Cost (US$):
Setup Time (days): 7 Breakdown Time (days): 5
Media Treated: Soil (ex-situ); Natural Sediment (ex-situ)

Contaminants Treated:

	Untreated:	Treated:	% Removal
Nonane	40,000 ppm	<50 ppm	
Decane	40,000 ppm	<50 ppm	

Clean-up Goals < 100 pm TPH

Emissions/ByProducts: Carbon Dioxide; Water Vapor

Description: Property clean-up; Waste lagoon bed contaminated with manufacturing lubricant residuals. Treatment cost: Confidential.

Project: S & S Flying Services **Year: 89**
Location: Marianna, Florida, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
RCRA Corrective Action	Diane Jackson	(404) 347-3931

Not Audited

Feed Rate (Tonne/hr): 12 Amount Treated (Tonne): 16000
Treatment Cost (US$):
Setup Time (days): 14 Breakdown Time (days): 10
Media Treated: Soil (ex-situ)

Contaminants Treated:

	Untreated:	Treated:	% Removal
Toxaphene	688 ppm	<1.5 ppm	>99.99
1,2,4 Trichlorobenzene	525 ppm	<1.1 ppm	>99.99

Clean-up goals: Clean-up plan coordinated by US-EPA Region 4

Emissions/ByProducts: CO_2, H_2O, HCl

Description: Thermal desorption of pesticides from soils including the subsequent treatment of VOC and HCl laden off-gases. Treatment cost: Confidential.

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Atomic Energy of Canada Ltd., In-Situ Stabilization

11-Dec-97

TechID: 2

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals, Radionuclides

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

In-situ treatment is being investigated by AECL. Sediment would be dewatered by consolidation under a geotextile fabric, and then covered with clean fill material to grade level. This would allow land to be reclaimed for use. This technology may be applicable to sediments in which the contaminants of concern have displayed little mobility.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals To be determined.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Not Applicable

Developers:

Atomic Energy of Canada Limited Research
Chalk River Laboratories
Chalk River, Ontario
Canada K0J 1J0
Notes

Contact: Charlesworth, D.H.
Phone: (613) 584-3311 Ext:
Fax: (613) 584-4024
Email:

Vendors:

Atomic Energy of Canada Limited Research
Notes

Contact: Moschuk, L.A.
Phone: (613) 584-3311 Ext:
Fax: (613) 584-4024
Email:

Literature References:

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Atomic Energy of Canada Ltd., Joule Melter

11-Dec-97

TechID: 113

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☐

Description:

Joule melting incineration results in the destruction, by burning, pyrolysis, or dissolution, of hazardous materials by placing them on the surface of a pool of molten glass. Solids residues melt into the pool of molten glass and are stabilized within the glass when removed and cooled.

The glass is heated until molten, at which time it becomes a conducter of electricity, and is then heated directly by the electrical current passing between submerged electrodes. This direct heating eliminates carbon dioxide and water vapour emissions associated with the burning of fossil fuels, thus reducing off-gas volumes. The process has been successfully demonstrated in stabilizing both nuclear wastes and non-nuclear hazardous waste containing heavy metals.

Limitations:

Efficiency Description: Excellent

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.125

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $700.00 – $1,800.00 Average Cost (US$/Tonne): $1,400.00

This is a projected unit cost.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Durable silicate glass waste and off-gases

Developers:

Atomic Energy of Canada Limited Research
Whiteshell Laboratories
Pinawa, Manitoba
Canada R0E 1L0

Contact: Harvey, K.
Phone: (204) 753-2311 Ext:
Fax: (204) 753-8404
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Atomic Energy of Canada Ltd., Radiolytic Dechlorination

11-Dec-97

TechID: 157

Technology Type: Chemical

Contaminants Treated: PCB's, Halogenated Organics

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

PCB's or PCB-contaminated items (including soil) are taken in alkaline iso-propanol solution and irradiated to a dose of < 10 (~1% solution). The effect of various organic and inorganic additives on the dechlorination process have been studied. The products of radiolytic dechlorination are biphenyl, acetone and inorganic chloride (NaCl or KCl, with NaOH or KOH used as the alkali). The conversion of PCB's into biphenyl is via stepwise dechlorination and the conversion is complete at the optimized dose. The work has been done with gamma irradiation; similar results would be expected with x-ray or electron irradiation.

Limitations: The process has to be carried out under inert atmosphere. It does not proceed in the presence of oxygen.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Negligible but controllable levels of H2, acetone, CH4 and iso-propanol.

Developers:

Atomic Energy of Canada Limited Research
Whiteshell Laboratories
Pinawa, MB
Canada R0E1L0
Notes

Contact: Kremers, W.
Phone: (204) 753-2311 Ext:
Fax: (204) 753-8802
Email:

Atomic Energy of Canada Limited Research
Whiteshell Laboratories
Pinawa, Manitoba
Canada R0E 1L0
Notes

Contact: Singh, Ajit
Phone: (204) 753-2311 Ext:
Fax: (204) 753-8802
Email:

Literature References:

Author: **Singh, A., Kremers, W., Bennett, G.S.**
Title: Radiolytic Detoxification of Polychlorinated Biphenyls
Journal: Proc. Intl. Conf. New Frontiers Haz. Waste Manag./EPA/600/9-85/025, p. 489 Date: **Jan 1985**

Author: **Singh, A., Kremers, W., Smalley, P., Bennett, G.S.**
Title: Radiolytic Dechlorination of Polychlorinated Biphenyls
Journal: Radiat. Phys. Chem., _25, 11 Date: **Jan 1985**

Author: **Bennett, G., Saunders, C., Singh, A.**
Title: Preliminary Economic Evaluation of the Destruction of Polychlorinated Biphenyls by Irradiation, RC-73
Journal: Date: **Jan 1988**

Author: **Singh, A., Kremers, W., Smalley, P., Bennett, G.S.**
Title: Radiolytic Detoxification of Polychlorinated Biphenyls
Journal: An AECL Report (RC-1504) Date: **Jan 1988**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Atomic Energy of Canada Ltd., Solidification/Stabilization

11-Dec-97

TechID: 328

Technology Type: Stabilization/Fixation

Contaminants Treated: Radionuclides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Various inorganic binders are presently being tested for the immobilization of contaminants through the solidification of the host sediment. Comrie silicate based binders, Portland cement and blast furnace slag, are some of the additives being used for solidification. The ultimate goal is to apply this technology on-site to avoid transportation and storage hazards.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals To be determined.

Setup/Feed: Setup Time (days): **1** Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$15.00 – $75.00** Average Cost (US$/Tonne): **$45.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Silicate based binders can meet or exceed drinking water guidelines for inorganics.

Developers:

Atomic Energy of Canada Limited Research
Chalk River Laboratories
Chalk River, Ontario
Canada K0J 1J0
Notes Additional Contact: L.A. Moschuk

Contact: Buckley, L.P.
Phone: (613) 584-3311 Ext:
Fax: (613) 584-4024
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

B.A. Brown Thermal Oxidation

19-Dec-97

TechID: 19

Technology Type: Incineration

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

Present technology equipment for soils includes a counter-current flow rotary kiln drier with gas fired secondary combustion chamber, accessory cyclones and baghouses capable of 250 tonnes per hour.

Throughput is primarily dependent upon water and clay size content of process materials and to a lesser extent upon concentration of hydrocarbons where dilution may be required, or where there is a need to introduce cementing agents to the stream to produce a final product which will not leach transition metals. High water content increases energy costs. Pre-conditioning by windrowing sediments, tarped and under negative air if required, can be used to reduce moisture before actual treatment.

The thermal oxidation plant requires access to a minimum 150 mm diameter gas line. The plant is also limited to sites having 4.15 m headroom for access, but can be transported by special over-size and over-weight permit on highways.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Site specific C of A required for each setup location

Setup/Feed: Setup Time (days): 6 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 31

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $86.00 – $95.00 Average Cost (US$/Tonne): $90.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Inert mineral soil, water, carbon dioxide and baghouse dust

Developers:

Bruce A. Brown Associates Limited
109 Vanderhoof Ave., Suite 2
Toronto, Ontario
Canada M4G 2H7
Notes

Contact: Brown, B.A.
Phone: (416) 424-3355 Ext:
Fax: (416) 424-3350
Email:

Vendors:

Canadian Eagle Recyclers Inc.
16 Melanie Drive
Brampton, Ontario
Canada L6T 4K9
Notes

Contact: Mittleman, M.
Phone: (416) 458-1005 Ext:
Fax: (416) 458-4149
Email:

Literature References:

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Babcock & Wilcox, Cyclone Vitrification Technology

19-Dec-97

Technology Type: Vitrification TechID: 18

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The cyclone furnace is relatively new to the vitrification of hazardous wastes, but is proven as a slagging combustor. The Babcock & Wilcox (B&W) cyclone furnace is a well-known coal combustion device that has been used for commercial steam generation since the 1940's with over 26,000 MW of installed electrical capacity. The combination of high heat release rates and high turbulence assures that the temperatures required for melting the inorganics (ash) in the fuel are reached and a vitrified slag is produced.

When used as a glass melter, the same properties of the cyclone furnace allow vitrification of the inorganic constituents while very high destruction and removal efficiencies are reached for the organic constituents. The primary components of cyclone vitrification technology include the feed system, the cyclone furnace (melter), and the flue gas system. The feed enters the cyclone and is thrown to the walls where organics are oxidized and the inorganics form a layer of molten glass that flows to the bottom of the cyclone and out a glass spout. Flue gases flow through the boiler where they are cooled, and then continue through the emissions control devices. The final configuration for the system depends heavily upon the specific application.

Limitations: Requires recycle for complete capture of volatile species. Pour point of inorganic mixture should be < 2600 ° F. (Fluxing agents can be added to adjust the viscosity some).

Efficiency Description: Have achieved 99.99% removal of organics

Government Funding: SITE

Environmental Concerns: Requires monitoring of stack emissions.

Health & Safety Plan Available: ☒

Regulatory Approvals EPA permits for local demonstrations.

Setup/Feed: Setup Time (days): **21** Breakdown Time (days): **14**

Feed Rate Average (Tonne/hr): **0.3**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$465.00 – $600.00** Average Cost (US$/Tonne): **$530.00**

Capital cost: $35.00 - $50.00 US$/tonne. Costs would be higher if remote operability were required and could be lower for some applications.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Air - flue gas after particulate collection and scrubbing

Developers:

Babcock & Wilcox
1562 Beeson St.
Alliance, OH
USA 44601-
Notes Research and Development Division

Contact: Holmes, Mike
Phone: (330) 829-7662 Ext:
Fax: (330) 823-0639
Email: Mike.j.holmes@mcd

Vendors:

Babcock & Wilcox
2220 Langhorne Rd., P.O.B. 1048
Lynchburg, VA
USA 24506-
Notes NESI

Contact: Reynolds, Evans
Phone: (804) 948-4615 Ext:
Fax: (804) 948-4802
Email: evans.reynolds@bw.

Literature References:

Author: **Babcock & Wilcox**
Title: Babcock & Wilcox Cyclone Furnace Vitrification Technology : Applications Analysis Report
Journal: US EPA 540/AR-92/017 Date: Aug 1992

Author: **Staley, L., et al**
Title: Babcock & Wilcox Cyclone Furnace Vitrification Technology
Journal: EPA Site Applications Analysis Report Date: Aug 1992

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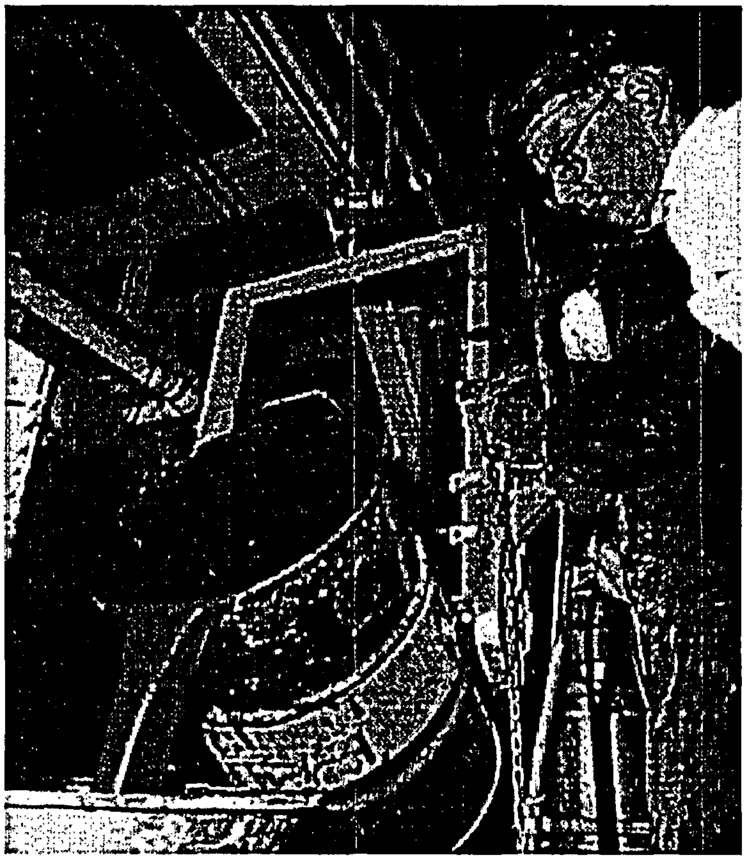
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Babcock & Wilcox, Cyclone Vitrification Technology

19-Dec-97

Author: **Holmes, M.J., et al**
Title: Vitrification of Low Level Radioactive Waste in a Slagging Combustor
Journal: Environmental Restoration 95 Conference Proceedings — Date: **Aug 1995**

Author: **Scotto, M.V., et al**
Title: Cyclone Vitrification of High Sodium Content Low-Level Radioactive Waste
Journal: Waste Management 96 Conference Proceedings — Date: **Feb 1996**



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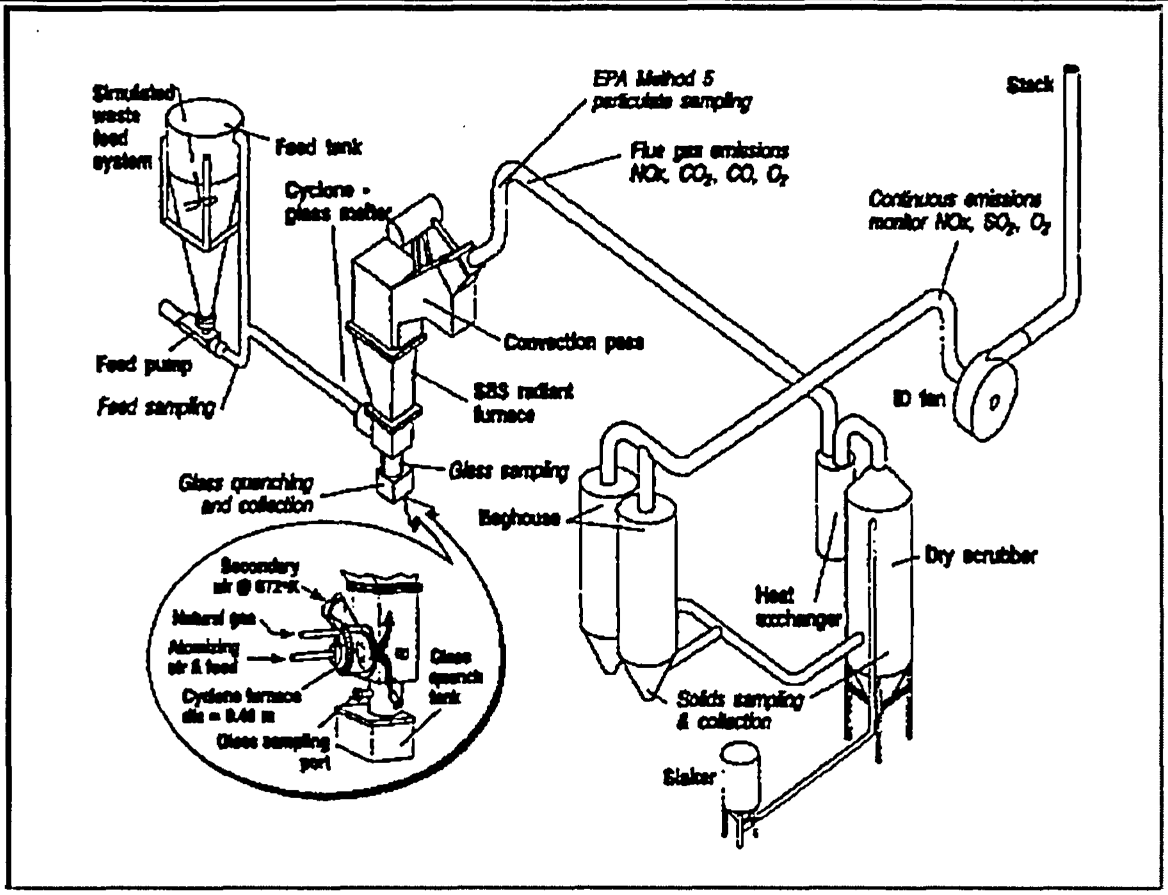
Babcock & Wilcox, Cyclone Vitrification Technology

19-Dec-97



Project: B&W Cyclone Furnace/SITE Evaluation **Year: 91**

Location: Alliance, OH, USA Pilot Scale

Client/Funding Agency	Contact	Phone
EPA RREL	Laurel Staley	

Not Audited

Feed Rate (Tonne/hr): 2.5 Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 21 Breakdown Time (days): 14

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal	Untr. Leach.	Tr. Leach.
Lead	7390 ug/g	2432 ug/g	29.2	75.6-125	<0.39
Chromium	1339 ug/g	2169 ug/g	78-95	1.8-3.9	0.30
Anthracene	4710 ug/g	Non-det.	>99.996	N/A	N/A
Dimethy/Pthalate	8340 ug/g	Non-det.	>99.998	N/A	N/A

Cleanup Goals: TCLP: PB <5.0 mg/l ; Cr < 5.0 mg/l ; DRE's (Both Anthracene and Dimethyl Pthalate) > 99.99 %.

Emissions/ByProducts: Typical flue gas compositions (CO2, N2, H2O, etc.) with trace pollutants within permit levels.

Description: Pilot test of technology. See US EPA report #PB93122315.

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Base Catalyzed Decomposition Process (BCDP)

19-Dec-97

Technology Type: Chemical TechID: 22

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The BCDP process was developed in the US EPA when it was determined that KPEG could not effect complete dechlorination of PCB's of other halogenated pollutants. Further, the chemistry of BCD is Catalytic Transfer Hydrogenation. The process employs hydrogen bearing materials such as hydrocarbons as source of hydrogen rather than molecular hydrogen which pose a serious threat to safe operation of treatment processes. Hydrogen liberated from hydrogen donors is in the form of free radicals and can effect at temperatures of 280 to 350 C reductive dehalogenation, desulfuration, denitration, etc. of toxic and hazardous compounds.

BCDP has also been demonstrated to effectively degrade polynuclear aromatic hydrocarbons, halogenated volatiles and semi-volatiles, pentachlorophenol, herbicides, pesticides and dioxins/furans.

Contaminated material is screened and crushed prior to transfer to a rotary reactor. Within the reactor the waste, mixed with sodium bicarbonate, is heated to approximately 350 degrees Celsius for one hour (usually). Organics are decomposed and volatilized. The vapours are filtered and scrubbed.

PCBs and other organics removed in the treatment process (ie. solids contaminated with dust and activated carbon) are slurried with a high boiling point hydrocarbon oil, catalyst and NaOH. The slurry is mixed, heated (approx. 350 degrees Celsius) for an additional 2 hours to complete decomposition. After treatment the oil may be burned or reclaimed.

The full scale operation currently requires approximately one acre of land to support 6 trailers (including analytical equipment). Once development is complete the operation is expected to need only four trailers.

Limitations:

Efficiency Description: >99.995% demonstrated on PCBs (achieved 99.9999% destruction on Waukegan Harbour sediment)

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals The BCDP has been approved by the US EPA for treating PCP, PCDD's, PCDF's, pesticides and other pollutants in sediments and soil on wood preserving sites. BCD has been approved for treating PCB's in soil and in liquids in concentrations up to 20%.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 1.25

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $245.00 – $245.00 Average Cost (US$/Tonne): $245.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: clean solids, clean gas, treated water

Developers:

U.S. EPA Risk Reduction Laboratory
26 West Martin Luther King Drive
Cincinnati, OH
USA 45268-
Notes

Contact: Rogers, Charles
Phone: (513) 569-7626 Ext:
Fax: (513) 569-7787
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Base Catalyzed Decomposition Process (BCDP)

19-Dec-97

Project: PWC Guam **Year: 94**

Location: Guam

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PCB's

Emissions/ByProducts:

Description: A series of tests using a two-liter mini STR (Stirred Tank Reactor) along with a 400-gallon capacity STR were conducted at the site. The results indicate that the STR operated under given formula/recipe achieved the goal of reducing PCB concentration in the residue mixture from 10% to non-detectable (less than 0.5 ppm) in 4 hours, under a temperature of 675°F (average). The data gathered from these tests will be used by the navy and EPA/RREL to test for its feasibility and applicability in treating PCB wastes which are being offloaded from the Navy ships. The wastes generally contain up to 35% of PCB. The BCDP system we have deployed to Guam (the two stage process) is currently being used by a Navy contractor to clean up an estimated 5,500 tons of PCB contaminated soil. The project will be completed in June of 1996.

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Batelle Northwest In-Situ Vitrification

19-Dec-97

TechID: 107

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

In Situ Vitrification (ISV) converts contaminated soils, sediments and sludges into a solid rock. During processing, organic materials are destroyed and inorganic species are dissolved in or chemically bonded to the multi-ton block produced.

In operations, the area to be treated is covered by a hood and electrodes are set in the surface soil. Power is passed among the electrodes causing the soil to melt. Melting continues and the electrodes move downward until the desired depth is achieved. At this time, power is discontinued and the soil solidifies into a large, impermeable rock.

Limitations:

Efficiency Description: DRE typically 1 000 000 to 1 000 000 000

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Over a dozen different applications currently being prepared. Records of decision have been issued for several applications including MI, WA, TN, IL, TX, UT & CO.

Setup/Feed: Setup Time (days): 2 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.6

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $450.00 – $550.00 Average Cost (US$/Tonne): $500.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Gaseous effluents met all applicable standards in testing performed

Developers:

Batelle Northwest
P.O.Box 999
Richland, WA
USA 99352-
Notes

Contact: Thompson, L.E.
Phone: (509) 376-5150 Ext:
Fax: (509) 372-0867
Email:

Vendors:

Geosafe Corp. (Port of Benton Bldg.)
2950 George Washington Way
Richland, WA
USA 99352-
Notes

Contact: Hansen, J.E.
Phone: (509) 375-0710 Ext:
Fax:
Email:

Literature References:

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Beaver Dredging Pre-treatment

19-Dec-97

Technology Type: Pre Treatment TechID: 26

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydr^^arbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Sludge

Pre-treatment

Development Stage: Commercial **Country Of Origin:** The **Portable:** ☒

Description:

Pre-treatment of dredged material is applied to reduce the volume of material requ' arge percentage of contaminants are generally associated with the finer fractions in sediment, clay ed to concentrate these fractions to reduce the volume of material requiring cleaning. 7 , are considered relatively clean.

The utilization of belt processes, pressure filters, vacuum filters and/or decantation centrifuges, along with ives, are further employed to squeeze the water out of the silt to produce a firm cake. The water is then clarified for discharge and the contaminants are economically and environmentally safe for temporary storage having been reduced to a minimal volume of dry material.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Contracts with Dutch municipalities and Municipality of Hamburg

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 12.5

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Dewatered filter cake; concentrated contaminated material

Developers:

Boskalis Dolman
Taankade 22
Dordrecht, TN
The Netherlands 3311 -
Notes

Contact: van Hemert, J.R.K.
Phone: 31 78 149077 Ext:
Fax: 31 78 143531
Email:

Vendors:

Beaver Dredging Company Ltd.
,
Notes

Contact: Waring, J.M.
Phone: Ext:
Fax:
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Bennett Remediation Technologies, Thermal Oxidizer

19-Dec-97

TechID: 317

Technology Type: Thermal, Incineration

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☐

Description:

The BRT Thermal Oxidizer consists of a rotary kiln primary combustion chamber (PCC), an air mixing chamber, a secondary combustion chamber (SCC), and air pollution control equipment (APCE) to meet all regulatory requirements.

PCC: The kiln consists of a two component refractory lined steel drum complete with refractory lifters. The speed of the kiln (1 to 4 RPM) and the temperature of the operation (800 to 1500°) are determined by the type of soil (clay versus sand), type of chemical contamination (volatile versus heavy asphalts), and moisture.

To maximize the waste handling capacity, the kiln is operated in a controlled air mode. The kiln thus operates in a partial pyrolytic mode and the organics vapourized from the waste feed form a low quality fuel gas that flows to the SCC. The decontaminable soils flow counter-current to the combustion gases in the kiln and pass through a soaking zone where high temperatures and radiant heat from the burners flame and the controlled introduction of air directly into the soil pile completes the removal and destruction of any residual organics.

SCC: The kiln exit gases are directed to the SCC. The SCC module consists of a refractory lined high efficiency side fired burner system, a vertically oriented retention chamber, and a bottom ash removal conveyer. The complete destruction of hazardous wastes is achieved in this unit by maintaining the combustion gases at elevated temperatures of 1800-2000°F for a residence time of 1 to 2 seconds in a highly turbulent mode. Air injection is used to introduce turbulence and to minimize NO formation. Heat is provided by oxidizing the pyrolytic flue gas from the kiln and /or by firing liquid waste fuels in the SCC.

APCE: The gas cleaning module is a uniquely designed transportable dry scrubber system consisting of a gas quench section, a dry lime scrubber, two high temperature fabric filter houses, a variable speed ID fan, and a stack. The cleaned exhaust gases are discharged through the stack complete with a continuous emission monitoring (CEM) system. The key premise used in selecting and integrating these components was that the system required high scrubbing efficiency, high on stream reliability, and low maintenance. The gas cleaning module removes both submicron particulates and acid gases (HCl and SO2) from the quenched combustion gases.

Limitations: Cannot treat metals.

Efficiency Description:

Government Funding:

Environmental Concerns: As long as unit is maintained and operated correctly, there should be no difficulty in meeting emission limits.

Health & Safety Plan Available: ☐

Regulatory Approvals Permits obtained in Quebec, Saskatchewan, Alberta, B.C., and Alaska.

Setup/Feed: Setup Time (days): **21** Breakdown Time (days): **21**

Feed Rate Average (Tonne/hr): **30**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **– $100.00** Average Cost (US$/Tonne): **$100.00**

Assuming 10,000 tonnes; hydrocarbon contamination up to 10% / Final level Non-detectable; ex-situ treatment.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Bennett Remtech
#200, 1130 West Pender St.
Vancouver, B.C.
Canada V6E4A4
Notes

Contact: Ponn, Danny
Phone: (604) 681-8828 Ext:
Fax: (604) 681-6825
Email:

Vendors:

Bennett Remtech
#200, 1130 West Pender St.
Vancouver, B.C.
Canada V6E4A4
Notes

Contact: Ponn, Danny
Phone: (604) 681-8828 Ext:
Fax: (604) 681-6825
Email:

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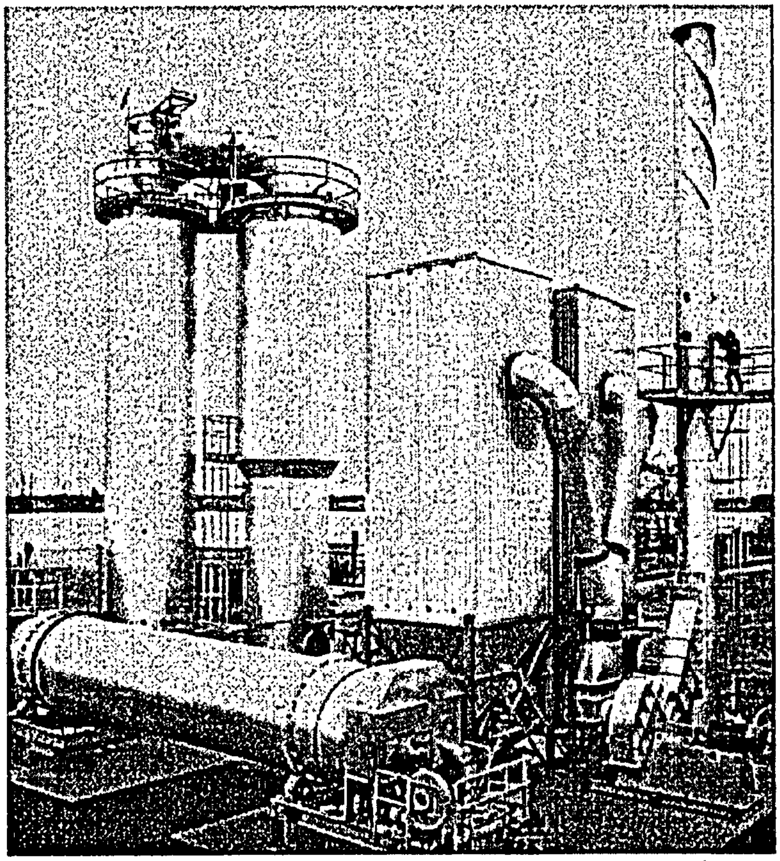
Literature References:



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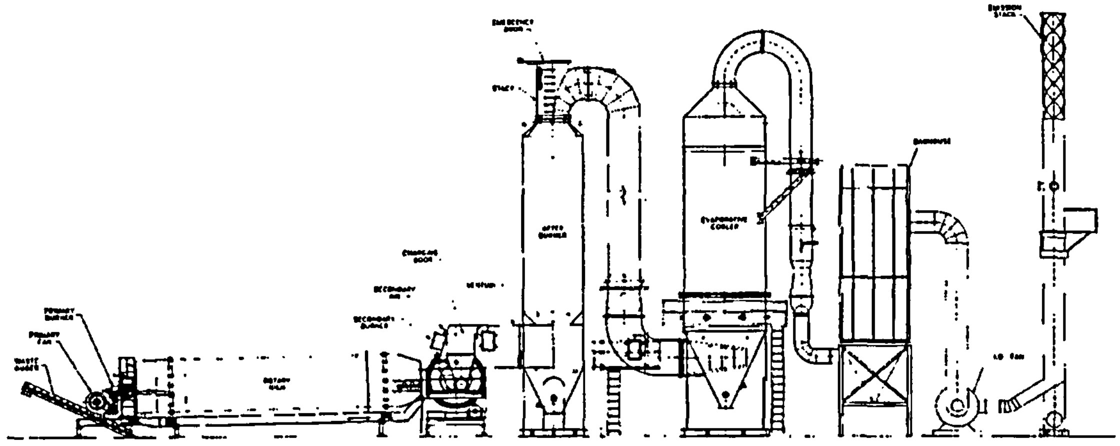
Bennett Remediation Technologies, Thermal Oxidizer

19-Dec-97



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Bergmann Soil/Sediment Washing

19-Dec-97

Technology Type: Soil Washing/Volume Reduction TechID: 27

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

Soil/sediment washing is a water based, volume reduction process whereby hazardous contaminants are extracted and concentrated into a small residual portion of the original volume using physical and chemical methods. The principal process involves transfer of the contaminants from the soil to the wash water and their subsequent removal from the water. Cleaned soil may be redeposited on site, or otherwise beneficially used. The small volume of contaminated residual concentrate is subsequently treated by other destructive or immobilizing processes.

Physical techniques employed include crushing, screening, wet classification, attrition scrubbing, gravity sedimentation and mechanical dewatering. Associated chemical aids include detergents, surfactants, chelating agents, coagulants, flocculants and pH adjustment.

Limitations: For soil washing to be economical, the contaminated material size distribution should not consist of more than 40% passing 45 microns or 325 mesh. Materials finer than this begin to reduce the amount of recovered clean soil for redeposition. In addition, the contaminated soil should contain less than 20% by volume of solid organic material such as leaves, roots, and twigs. Potential sites should have a minimum of 5000 tons of material in order to justify the fixed costs of mobilization and demobilization.

Efficiency Description: Have achieved >99% cleaning of soil

Government Funding: Great Lakes Cleanup Fund, ARCS, SITE, Superfund

Environmental Concerns: Can have air emissions when dealing with volatile or semi-solatile organics. Air emissions can be controlled.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): **10** Breakdown Time (days):

Feed Rate Average (Tonne/hr): **44**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$60.00 – $75.00** Average Cost (US$/Tonne): **$67.00**

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Water, fine grained soil wwith concentrated contamination, organic debris.

Developers:

Bergmann B.V.
Postbus 752, Industrieweg 47-49
Rotterdam, AT
The Netherlands 3000 -
Notes

Contact: Manheim, J.
Phone: 31 18 9113944 Ext:
Fax: 31 18 9117470
Email:

Vendors:

Linatex Canada Inc.
410-5255 Henri-Bourassa Blvd. W.
Montreal, Quebec
Canada H4R 2M6
Notes

Contact: Lee, R.
Phone: (514) 334-0252 Ext:
Fax: (514) 334-4588
Email:

Bergmann USA, Inc.
72-II West Stafford Rd.
Stafford Springs, CT
USA 06076-0535
Notes

Contact: Traver, R.P.
Phone: (615) 230-2100 Ext:
Fax: (615) 452-5525
Email:

Literature References:

Author: **Wastewater Technology Centre**
Title: THC Soil Recycling Demonstration Facility - Soil/Sediment Washing
Journal: GLCF Fact Sheet Number 16 Date:

Author: **O'Brien, S.C.**

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Bergmann Soil/Sediment Washing

19-Dec-97

Title: Bench-Scale Soils Washing Treatability on Pesticide
Journal: Bergmann USA — Date: **Mar 1992**

Author: **O'Brien, S.C.**
Title: Bench-Scale Soils Washing Treatability Evaluation on PAH/Creosote
Journal: Bergmann USA — Date: **Jun 1992**

Author: **Traver, R.P., O'Brien, S.**
Title: Demonstration of Bergmann USA Plant at the Toronto Harbour
Journal: Cleanu-up of Contaminated Site — Date: **Nov 1992**

Author: **Traver, R.P., O'Brien, S.C.**
Title: Demonstration of Bergmann USA Plant for Volumetric Reduction
Journal: EPA Site Review Conference, San Francisco, California, USA — Date: **Nov 1992**

Author: **O'Brien, S.C.**
Title: Bench Scale Soils Washing Treatability Evaluation on Radionuclides
Journal: Bergmann USA — Date: **Dec 1992**

Author: **Bergmann USA**
Title: Bench-Scale Sediment Washing Treatability Study of Toronto Harbour Dredge Spoil
Journal: — Date: **Mar 1993**

Author: **Richardson, T., Ehrenreich, L., et al**
Title: Toronto Harbour Commissioners Soil Recycle Treatment Plan
Journal: EPA SITE Applications Analysis Report — Date: **Apr 1993**

Author: **Mourato, Diana**
Title: Report on the Treatment of the Toronto Harbour Sediments at the THC Soil Recycling Plant
Journal: — Date: **Jun 1993**

Author: **Galloway, J., Snitz, F.**
Title: Pilot-Scale Demo of Bergmann Grain Size Separation on Sediments
Journal: U.S. Army Corps of Engineers — Date: **Sep 1993**

Author: **Hubbard, J., Jackson, T., et al**
Title: Bergmann USA Soil/Sediment Washing Technology
Journal: EPA SITE Applications Analysis Report — Date: **Sep 1993**

Author: **Traver, R.P., O'Brien, S.**
Title: Full-Scale Soils Washing Operations at Saginaw, MI and Toronto
Journal: HMCRI Superfund '93 Conference, Washington, DC, USA — Date: **Dec 1993**

Author: **Traver, R.P., O'Brien, S.**
Title: Full-Scale Soils Washing Applications at CERCLA, RCRA, DOE
Journal: HazMat South Regional Conference, Orlando, Florida, USA — Date: **Feb 1994**

Author: **Traver, R.P., O'Brien, S.**
Title: Full-Scale Soils Washing Applications at CERCLA, RCRA, DOE
Journal: HazMat Central Conference, Chicago, Illinois, USA — Date: **Apr 1994**

Author: **Traver, R.P., O'Brien, S.**
Title: Full-Scale Soils Washing Applications for CERCLA, RCRA, DOE
Journal: Air & Waste Management Association Annual Conference, Cincinnati, OH, USA — Date: **Jun 1994**

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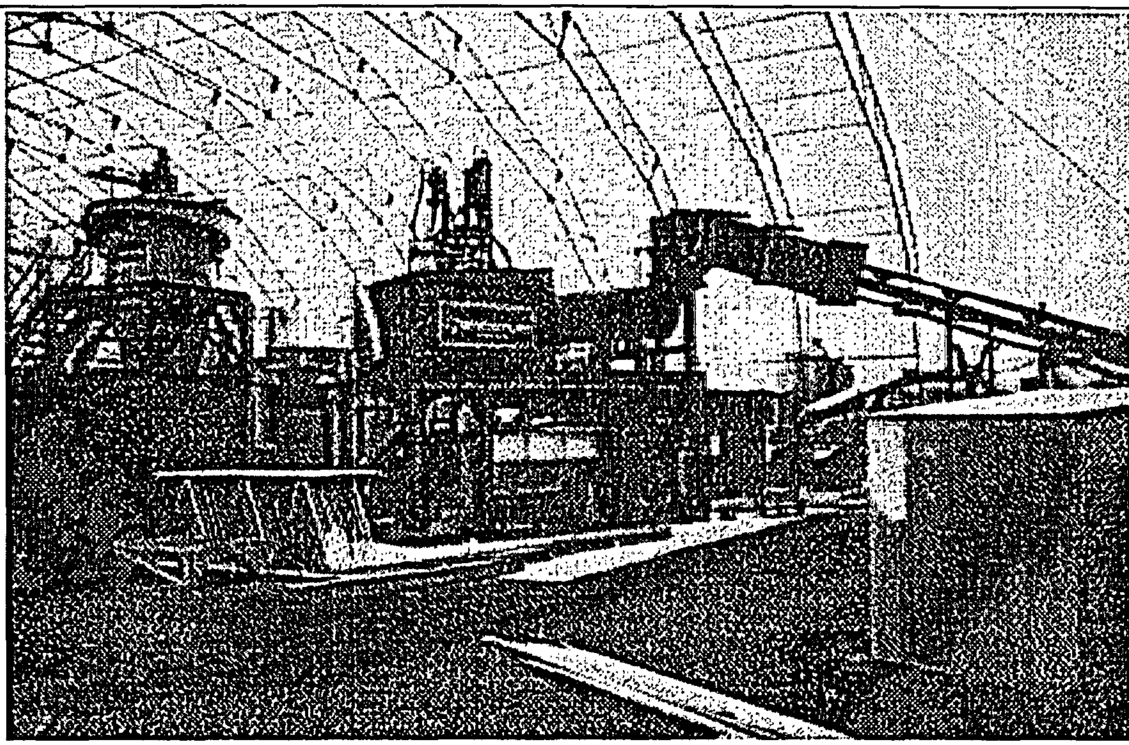
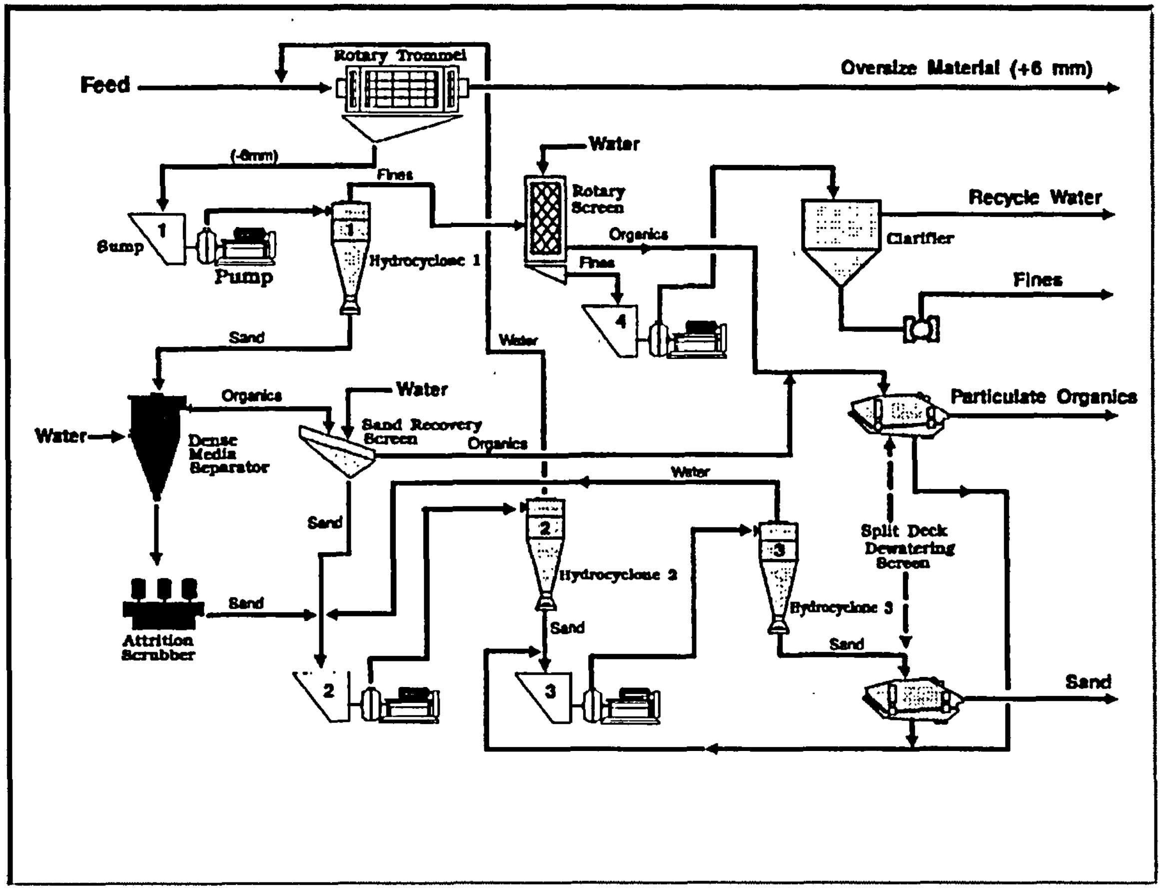
Bergmann Soil/Sediment Washing

19-Dec-97





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Bergmann Soil/Sediment Washing

19-Dec-97

Project: Nuclear Fuel Services **Year: 95**

Location: Erwin, Tennessee, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
EcoTek, Inc.	Greg Wagner/Rocky Crowe	

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne): 18000
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated: Ex-Situ Sediment
Contaminants Treated:
Emissions/ByProducts:
Description:

Project: Lead Battery Superfund Site **Year: 94**

Location: EPA Region 10, Oregon, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Canonie Environmental Services, Inc.	John Meardon/Paul Hohne/	-
-	Dave Ehlers	-

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne): 50000
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated: Ex-Situ Sediment
Contaminants Treated:
Emissions/ByProducts:
Description:

Project: Toronto Harbour Commisioners Soil Recycling Facility **Year: 92**

Location: Toronto, Ontario, Canada — Pilot Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273
Toronto Harbour Commision	-	-

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): 20
Amount Treated (Tonne): 200
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated: Sediment
Contaminants Treated: Cadmium; Copper; Iron; Lead; Magnesium; Silver; Zinc; BTEX; Oil & Grease; TPH; 2-3 PAH's; 4-6 PAH's
Emissions/ByProducts:
Description: Prior to the pilot-scale demonstration, Bergmann conducted bench-scale testing with several kg of Toronto harbour sediment. The results of the testing were to provide guidance in selection of the optimal unit processes and chemical additives for application at pilot-scale.

The pilot-scale treatment demonstration was conducted in conjunction with a dredging project completed under the auspices of the Contaminated Sediment Removal Program. Approximately 200 m^3 of sediment were removed from the Parliament St. boat slip in Toronto's Inner Harbour and delivered to the THC site. All sediment was fed into the Bergmann process by bobcat loader following which material was transported by conveyors and pumps/pipes.

The loader dumped the wet sediments onto a grizzly screen to remove particles larger than 50 mm. (See Map). Followed by hydrocyclone for further density separation and light organics removal. The contaminated fines were sent on to either the Metanetix or SNC-Lavalin Bio Slurry for further treatment. (Please refer to the Toronto Harbour Commisionser's project under each of those technologies).

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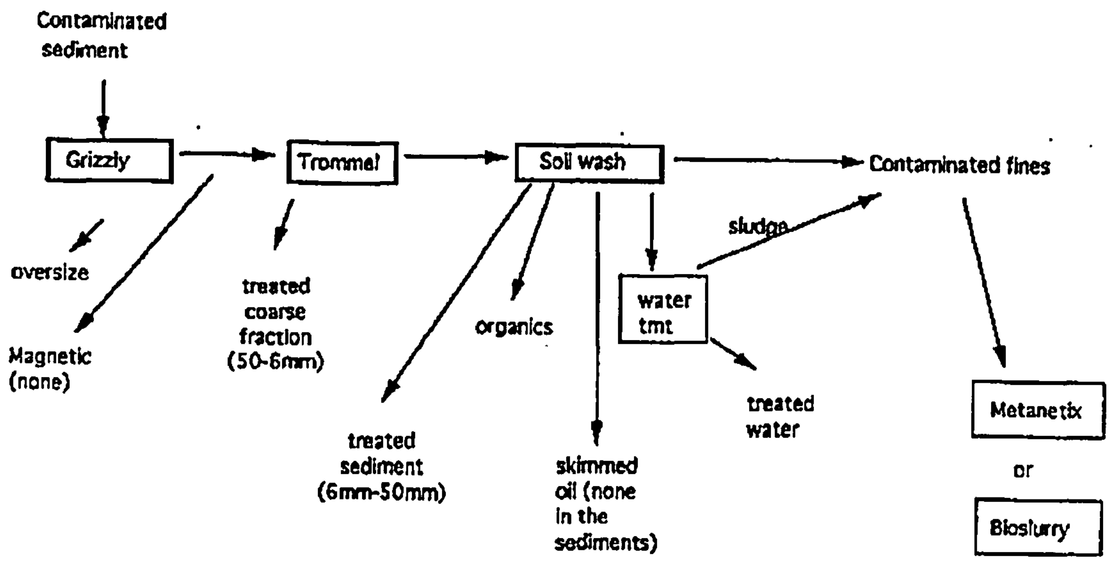
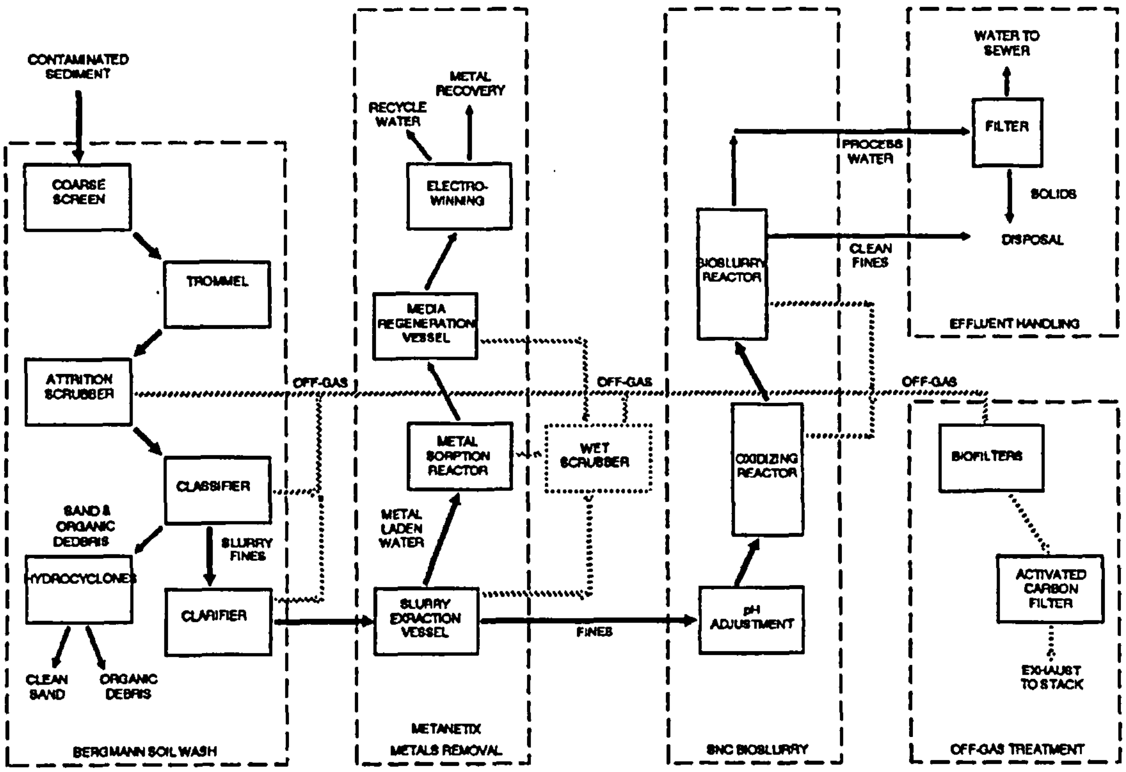
Bergmann Soil/Sediment Washing

19-Dec-97





Project: **Saginaw River PCB Sediment** | Year: 92

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Bergmann Soil/Sediment Washing

19-Dec-97

Location: Essexville, Michigan, USA

Pilot Scale

Client/Funding Agency	Contact	Phone
US ARCS Program/U.S. Army Corps of Engineers	Jim Galloway	(313) 226-6760

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 500

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:

Contaminants	Untreated: (ug/g)	Treated: (ug/g)	% Removal:
PCB's	1.2	0.21	82
Cadmium	0.5	0.06	88
Chromium	24	10.8	55
Mercury	0.044	0.008	82
Nickel	11.38	3.3	71
Lead	19.03	7.42	61
Zinc	95	17.1	82
Oil and Grease		1400	
Naphthalene		2.05	
Benzo(a)pyrene		0.24	

Emissions/ByProducts:

Description: The objective of the Saginaw River pilot-scale demonstration was to evaluate sediment washing as a treatment technology for sediments from the Saginaw River and Bay Area of Concern. Specific objectives of the demonstration included determining: the efficiency of the sediment washing process in separating silts, clays and particulate organics from predominantly sandy sediments; the effectiveness of various components of the system in achieving the desired separation; the handling and preprocessing requirements for the sediments; and the characteristics of each of the process output streams and their suitability for reuse or disposal.

Project: Sediment Washing Treatability Study

Year: 92

Location: Toronto, Ontario,Canada

Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated:

Chromium	94 ppm
Copper	92 ppm
Nickel	70 ppm
Iron	28,000 ppm
Lead	229 ppm
Zinc	156 ppm
O&G	5,000 ppm
TOC	14,500 ppm

Emissions/ByProducts:

Description: Bench scale studies were conducted prior to the pilot scale demonstration at Toronto Harbour. The purpose was to determine the optimum operating parameters for the pilot scale. Testing took place at Bergmann's facility (in Connecticut at that time)
RESULTS
Average removal of 96% was achieved with the Moncosolve 210 surfactant at a concentration of 0.1%.

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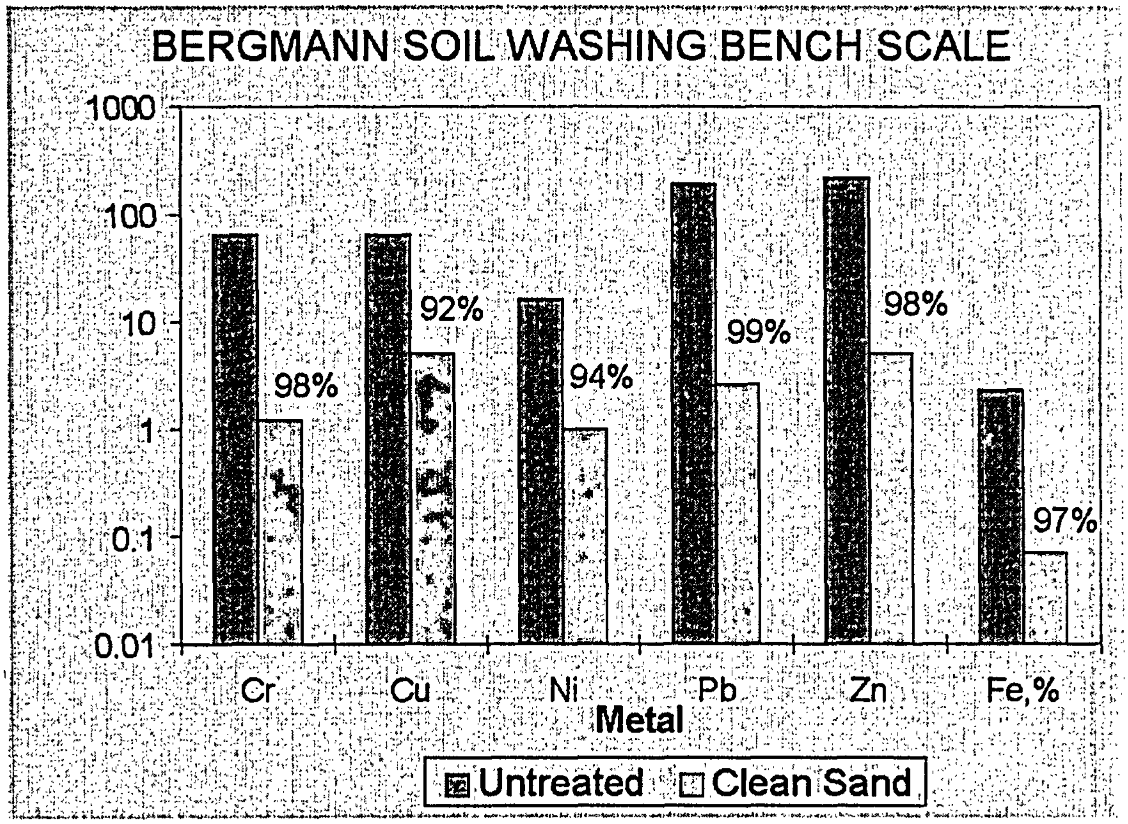

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Bio Separation Ltd. Biomagnetic Separation and Extraction

19-Dec-97

TechID: 33

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** United Kingdom **Portable:** ☒

Description:

The process has been developed to deal with the removal of metal ions from effluent streams at the ppm level. Two steps are involved in the procedure:
1) Mixing the effluent with a small quantity of a specially developed slurry to absorb the metal ions.
2) Removal of the added solids in a strong magnetic field, leaving a clean liquid with greatly reduced metal levels.

Originally the technique used specially prepared biological solids which could absorb metals and some pesticides. Alternatively an inorganic absorbent which is less expensive, but only tested for metals, can be used. The effluent stream must be neutral or slightly alkaline and contain no oxidation products. Lead, uranium, mecury, cadmium, cobalt, copper and chromium have been tested for efficient removal. The Platinum group may also be efficiently removed if the solution is heated in the mixing stage.

The microorganisms and their acquired material are removed and concentrated by passing the mixture up through metal balls mounted between a magnet. In this manner, the solids are retained on the balls and a clean liquid stream is discharged. As the balls accumulate the solids it is planned to continually remove them from the top and add clean balls at the base.

The processes have been developed over three years and are still at the laboratory stage. No specific application using larger scale tests have been made. A demonstration of the process can be given at the laboratory in Enfield.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.4

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $0.02 – $0.03 Average Cost (US$/Tonne): $0.02

Usually measured in volume units. Average cost for treatment $0.02 - $0.03/m³. Average feed rate: 6 liters/minute.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Decontaminated effluent, organisms and concentrated waste or metals.

Developers:

Bio Separation Ltd.
Aden Road, Ponders End
Enfield, Middlesex
United Kingdom EN3 7SY
Notes

Contact: Childs, H. W.
Phone: 081 805 3306 Ext:
Fax: 081 805 9664
Email:

Vendors:

University of Southampton
Institute of Cryogenics
Southampton,
United Kingdom SO9 5NH
Notes

Contact: Watson, J.H.P.
Phone: 44 703 592050 Ext:
Fax: 44 703 593053
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Bioforj Ont. Ltd., Enretech Bioactive Absorbents *19-Dec-97*

TechID: 322

Technology Type: Biological, Stabilization/Fixation
Adsorption.

Contaminants Treated: PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, VOCs, Halogenated Organics, BTEX, Explosives
Also treats HCl (Ennotech 1A)

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Cotton based cellulose fibre with naturally enhanced microbial population. Absorbs oils, sludges, PCB's from soils or directly. Enretech 1 will degrade hydrocarbons to carbon dioxide and water. Can be used to initially create a solid non-hazardous, non-leachable material (contaminate will be encapsulated) then the material will be activated using simple biological treatment. Sufficient nutrient and indigenous bacteria to degrade contaminants.

For Sediments: Biological treatment for petroleum hydrocarbons in sediment should work well. Our product will preferably give up water to encapsulate hydrocarbons thus providing an opportunity for treatment.

Limitations: Must be used in temperature range 40°F - 140°F for microbial activity. (Normal Biological Treatment considerations; not for heavy metals).

Efficiency Description: 95%

Government Funding:

Environmental Concerns: None - compostable.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days): 30

Feed Rate Average (Tonne/hr): 0.006

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $19.00

Assuming 10,000 tonnes. Media: Soil. Contaminant: Oil.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: None - totally biodegradable.

Developers:

Environmental Remediation Technologies

,

Notes

Contact:
Phone: Ext:
Fax:
Email:

Vendors:

Bioforj Ont. Ltd.
P.O.B. 156
Guelph, Ontario
Canada N1H6J9
Notes

Contact: Johnson, Robert
Phone: (519) 767-9854 Ext:
Fax: (519) 836-1602
Email: rejohnso@Uoguelph.

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

BioGenesis Entreprises Inc., BioGenesis Soil and Sediment Washing Process

19-Dec-97

TechID: 28

Technology Type: Metal Extraction, Organic Extraction, Soil Washing/Volume Reduction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

BioGenesis has developed an innovative, ex-situ, on-site, mobile one day set up and take down soil and sediment washing technology. The process uses a proprietary blend of complex bioremediating surfactants, water, heat, and mixing friction to clean PCB's, PAH's, PCP, wood treating wastes, creosote, crude oil, and fuel oil and distillates. The extraction efficiency achieved is as high as 99.9%.

The soil washing system is a batch process that washes sand and gravel at 30 yards/hour. The sediment washing system is a continuous flow process that washes silt and clay at 15 tons/hour. Both processes may be paralleled for greater throughput.

The soil washer is a trailer mounted gondola plumbed for air mixing, water/chemical addition, oil skimming and liquid drainage. Water, BioGenesis (TM) Cleaning Chemicals, and soil are loaded into the gondola. Aeration nozzles in the bottom of the gondola feed compressed air to agitate the slurry for about 30 minutes. Oil is skimmed for reclamation or disposal, wash water is drained and recycled and the clean soil is dumped by raising the unit's dump mechanism. The gondola is equipped with an emission control system to trap VOC's if necessary.

The sediment washing process begins by injecting sediment slurry into a collision chamber where it collides with water and cleaning chemicals. The slurry flows to a collision scrubber where it is further cleansed and then to the primary dewatering device (such as a sand screw) where the majority of the sediment is dewatered and conveyed to a holding area. The contaminated process water is then treated using standard water treatment equipment and techniques and then recycled back through the system.

Limitations: The process is not affected by high contamination concentrations or moisture content. The process is most efficient at temperatures above zero degrees centrigrade. Initial removal of gross oversized materials may be required. Extraction efficiency will depend on the soil matrix and initial contamination levels.

Efficiency Description: 80%-99% target organic pollutants are extracted depending on contamination variables

Government Funding: Great Lakes Cleanup Fund, SITE

Environmental Concerns: Site specific.

Health & Safety Plan Available: ☐

Regulatory Approvals Bay Area Air and Water Management District of Northern California.

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 14

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $60.00 — $95.00 Average Cost (US$/Tonne): $75.00

Total amount treated: 5,000 tons. Contaminant: PCB's. Sediment/Clay only, PCB contaminated water cleaned on-site. Customer supplied utilities, excavation, soil movement before and after process. Initial level: 250 ppm. Final level: 5 ppm. Ex-Situ treatment. Capital cost: Not given.

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products: Only by-product is recovered inorganic contaminates.

Developers:

BioGenesis Enterprises, Inc.
610 West Rawson Avenue
Oak Creek, WI
USA 53154-
Notes

Contact: Rougeux, Tom
Phone: (414) 571-6230 Ext:
Fax: (414) 571-6231
Email: Rougeux@AOL.CO

Vendors:

BioGenesis Enterprises, Inc.
610 West Rawson Avenue
Oak Creek, WI
USA 53154-
Notes

Contact: Rougeux, Tom
Phone: (414) 571-6230 Ext:
Fax: (414) 571-6231
Email: Rougeux@AOL.CO

Literature References:

Author: **BioGenesis Enterprises Inc.**

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BioGenesis Entreprises Inc., BioGenesis Soil and Sediment Washing Process *19-Dec-97*

Title: Final Report: Bench Scale Studies of Thunder Bay Harbour Sediment: BioGenesis Washing Process: Appendix B: Galson
Journal: Laboratory Test Report Data Sheets with Mass Spectra for Semi-Volatiles
Date: **Aug 1993**

Author: **BioGenesis Enterprises Inc.**
Title: Final Report: Bench Scale Studies of Thunder Bay Harbour Sediment: BioGenesis Washing Process
Journal:
Date: **Aug 1993**

Author: **US EPA**
Title: BioGenesis Soil Washing Technology Innovative Technology Report
Journal: Site Superfund Innovative Technology Evaluation
Date: **Sep 1993**

Author: **Mohsen, A., Wilde, C.**
Title: PAH Removal Using Soil and Sediment Washing at a Contaminated Harbor Site
Journal: Remediation Journal
Date: **Jul 1994**

Author: **Gatchett, Annette**
Title: Site Technology Profile
Journal: US EPA Demonstration Program
Date: **Nov 1994**

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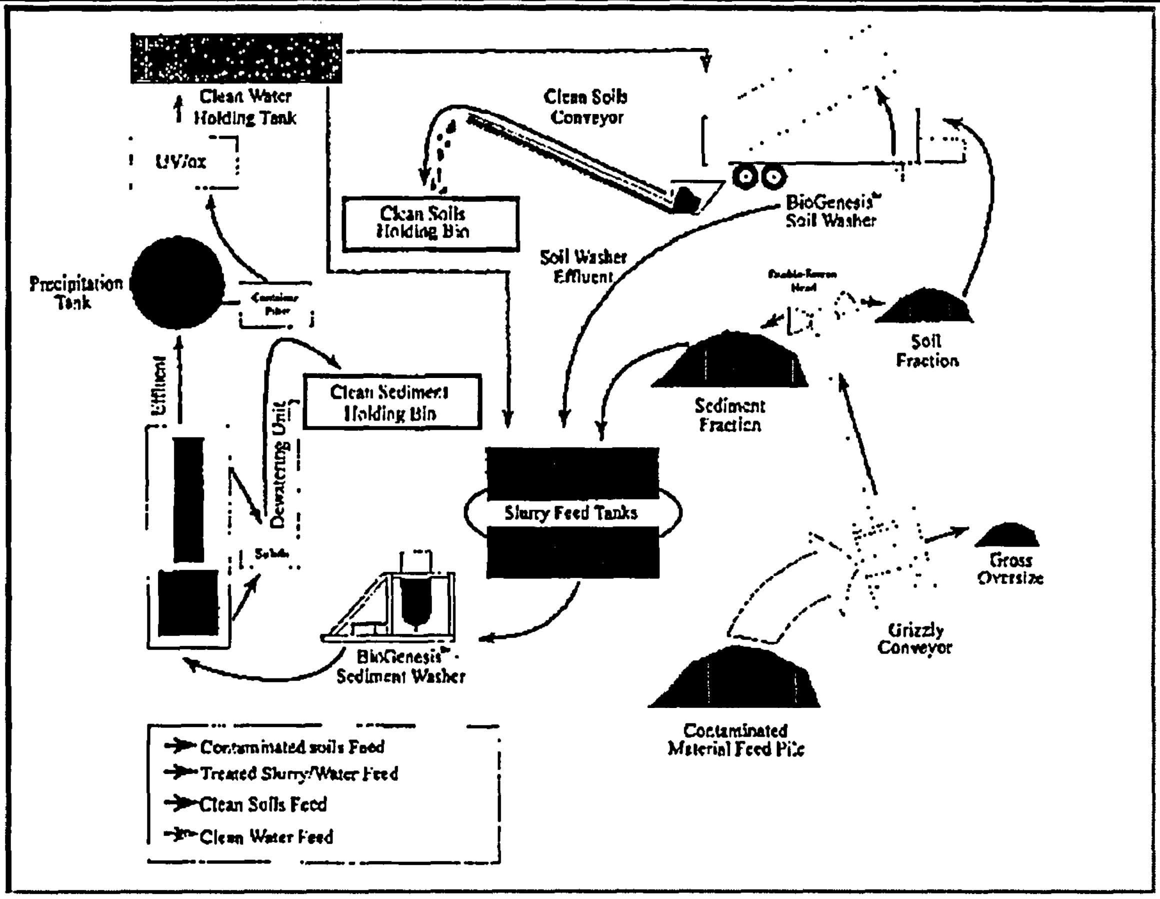

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Project: US Navy **Year: 95**

Location: , California, USA Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 15 Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 10 Breakdown Time (days): 4

Media Treated: Sand/Clay

Contaminants Treated:

Contaminant:	Untreated:	Treated:	% Removal
Lead	1350 ppm	25 ppm	98
PCB's	19 ppm	0.325 ppm	98

Emissions/ByProducts:

Description: BioGenesis has been contracted by the US Navy to conduct a pilot job based on the above results achieved at a California Naval Base. Pilot scale tests are scheduled for May '96.

Project: Koch Refining Company **Year: 93**

Location: St. Paul, Minnesota, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA SITE Program		

Not Audited

Feed Rate (Tonne/hr): 30 Amount Treated (Tonne): 3800

Treatment Cost (US$):

Setup Time (days): 3 Breakdown Time (days): 3

Media Treated: Soil

Contaminants Treated:

Contaminant:	Untreated:	Treated:	% Removal
Crude Oil	30,800 ppm	690 ppm	98

Cleanup Goal: 1000 ppm

Emissions/ByProducts:

Description: BioGenesis used its soil washing equipment to clean 3500 tons of crude oil contaminated soil at Koch Refining Company. The cleanup was monitored and tested by the US EPA as part of the SITE Program.

Project: Wood Treatment Facility (Confidential Client) **Year: 93**

Location: Confidential Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.18925

Treatment Cost (US$):

Setup Time (days): 1 Breakdown Time (days): 1

Media Treated: Soil

Contaminants Treated:

Contaminant:	Untreated:	Treated:	% Removal
TPH as Diesel	15,000 ppm	105 ppm	99
PAH's	1400 ppm	7 ppm	99
Pentachlorophenol	310 ppm	1.5 ppm	99
Dioxin/Furan	5.5 ppm	0 .01 ppm	99

Emissions/ByProducts:

Description: BioGenesis was contracted by a Fortune 500 company to perform a treatability study on a former wood treatment facility site. Based on the above results it was established that BioGenesis can efficiently and effectively remediate the site.

Project: Thunder Bay Harbour Project **Year: 92**

Location: Thunder Bay, Ontario Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund (COSTTEP)	John Shaw	(905) 336-6273

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BioGenesis Entreprises Inc., BioGenesis Soil and Sediment Washing Process

19-Dec-97

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4665

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.068

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. Over 80 % of the sediment was medium silt and finer (less than 38 microns in size). Settling times were far in excess of 5-7 minutes.

Contaminants Treated:

Contaminant	Untreated	Treated	% Removal
Oil & Grease	9%	0.36%	96
Semi-Vol. Hydrocarbons	2%	0.20%	90
Total Petroleum Hydrocarbons	5000 ppm	400 ppm	80-90
PAH's	4000 ppm	400 ppm	80-90

Emissions/ByProducts: Air emisions are minimal or nonexistant. Chemicals used are benign. Quality control monitoring is simple and straightforward. Concentrated contaminants are collected for treatment or disposal.

Description: Sediment contaminated from former wood-treating operations at Thunder Bay Harbour, Ontario, was washed in BioGenesis sediment washing equipment. The key parameters of the BioGenesis cleaning are the surfactant blend, wash temperature, and mixing efficiency. See Map for the Bench Scale flow diagram. First, a sizing step removed large particles. Then using saturated steam, the sediment was heated to 30-35 °C. Next, the heated sediment was mixed with BioGenesis cleaner and water under up to 10,000 psi pressure. The combination of chemical and physical force of impact loosened the bonding forces between the small sediment particles and the contaminant. The loosening process was completed in a collision scrubber wherein the charges on the contamination particles were aligned to facilitate separation. Finally, using standard hydrocyclones and a centrifuge, the oil and water were separated from the sediment.

RESULTS

Results using a prototype pilot washing machine showed extraction efficiencies of 96 % oil and grease, 80-90% TPH, 90 % SVHC's and 80-90 % PAH's. BioGenesis Entreprises, Inc. projects extraction efficiencies at full scale of 97 to 99 % for PAH's. Future tests are planned for extracting PCB's, dioxins, pesticides, and metals from sediment.

Cost Effieciency at Full Scale:

Soil washing is a batch process. The cost at full scale is estimated at US$40 to US$180 per metric tonne based on the type of sediment, the contaminants, the degree of contamination, and the target cleanup level. With a job size of 10,000 tons or greater, BioGenesis would be converted to a continuous process with correspondingly lower costs. Sediment washing is continuous process. Costs are estimated at $30 to $100 per metric tonne.

Estimated Feed Rate at Pilot Scale: 5 m^3/hr

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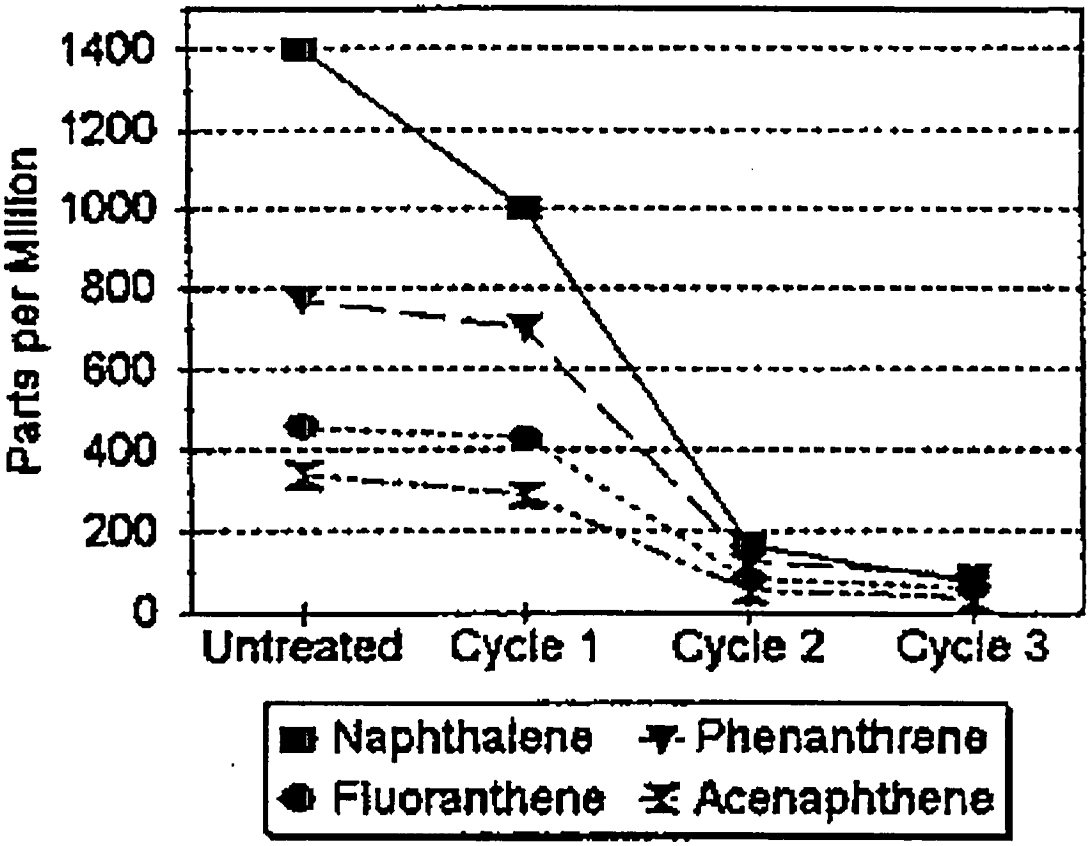

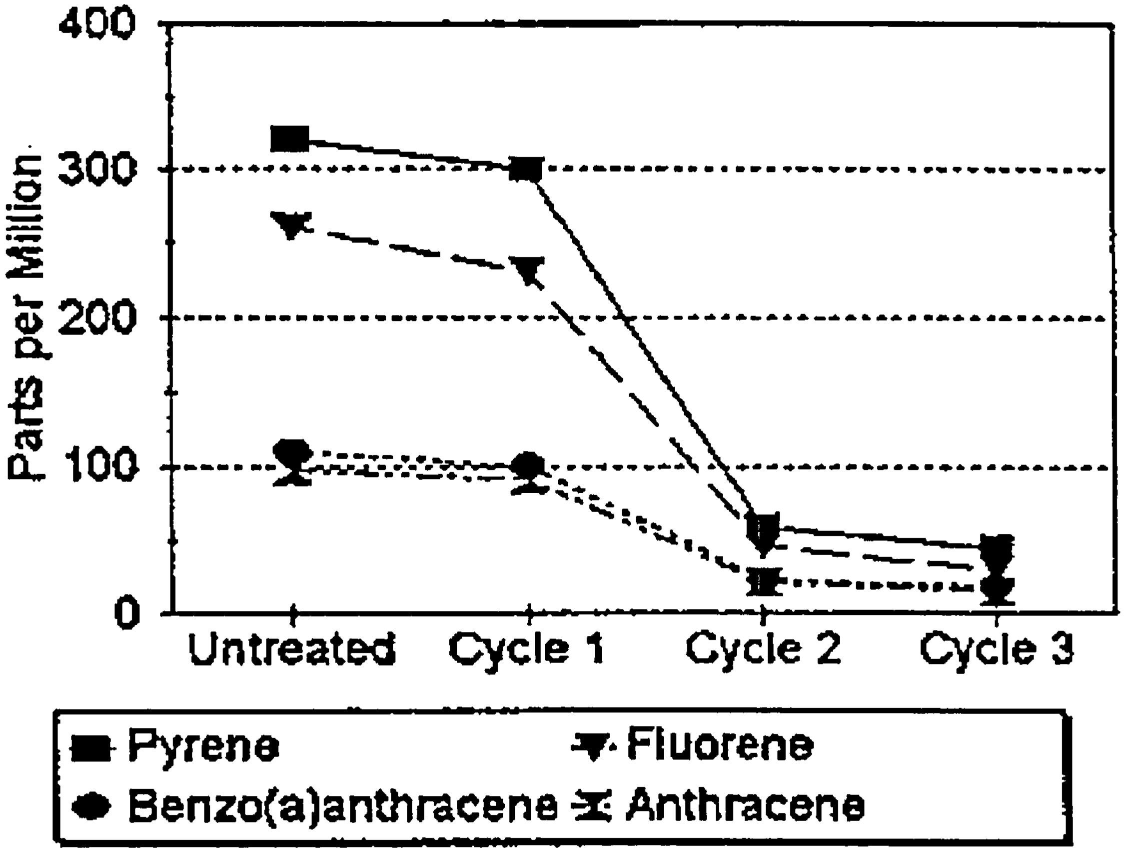

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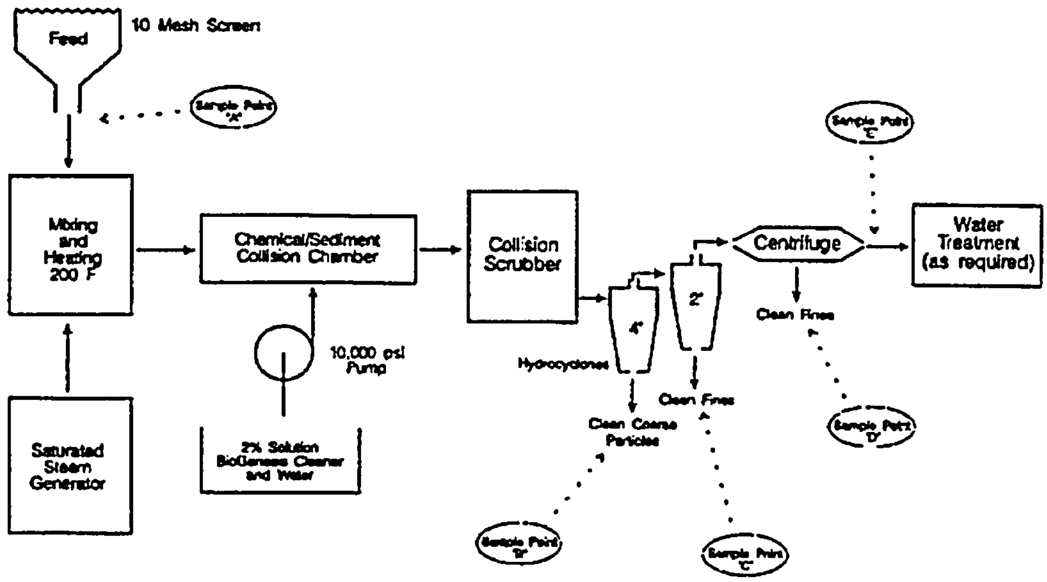
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

BioGenesis Entreprises Inc., BioGenesis Soil and Sediment Washing Process *19-Dec-97*



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Biogénie Biopile Process *19-Dec-97*

Technology Type: Biological TechID: 331

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Explosives

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

A typical biopile system has an asphalt or high-density membrane pad on which contaminated solids are piled; an overhead stray irrigation system for optimizing the moisture content of solids; and an underdrain connected to a reservoir to collect leachate. The system also should have a pump to draw air from/or push air into the pile to oxygenate it; and an impermeable sheeting covering the pile for air and water control during treatment. To date, more than 200,000 tons of solids contaminated with pentachlorophenol, polycyclic aromatic hydrocarbons and various petroleum products such as gasoline and diesel have been remediated using biopile treatments.

Limitations: Cannot remove non-biodegradable compounds and metals.

Efficiency Description: Removal efficiency: 86%.

Government Funding:

Environmental Concerns: The biopile process is environmentally safe. If operated properly, the process generates no liquid wastes and presents no risk of site contamination.

Health & Safety Plan Available: ☒

Regulatory Approvals Approvals from the Quebec Ministry of Environment and Wildlife.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 30

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $30.00 – $50.00 Average Cost (US$/Tonne): $40.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Biogénie Inc.
350 rue Franquet, entrée 10
Ste. Foy, Québec
Canada G1P 4P3
Notes

Contact: Sansregret, Jean-Luc
Phone: (418) 653-4422 Ext:
Fax: (418) 653-3583
Email:

Vendors:

Biogénie Inc.
350 rue Franquet, entrée 10
Ste. Foy, Québec
Canada G1P 4P3
Notes

Contact: Sansregret, Jean-Luc
Phone: (418) 653-4422 Ext:
Fax: (418) 653-3583
Email:

Literature References:

Author: **Pouliot, Y., Sansregret, J-L., Cyr, B.**
Title: Biodegradation/Bioventing Process for the Treatment of Organic Contaminants in Soil
Journal: Proceedings of ISECCEE Date: **Jan 1992**

Author: **Lei, J., Pouliot, Y., Sansregret, J-L.**
Title: Biopile Treatment of Diesel Contaminated Soils
Journal: Microbial Clean-up Date: **Jan 1993**

Author: **Lei, J., Sansregret, J-L, Cyr, B.**
Title: Biopiles and Biofilters Combined for Soil Cleanup
Journal: Pollution Engineering Date: **Jan 1994**

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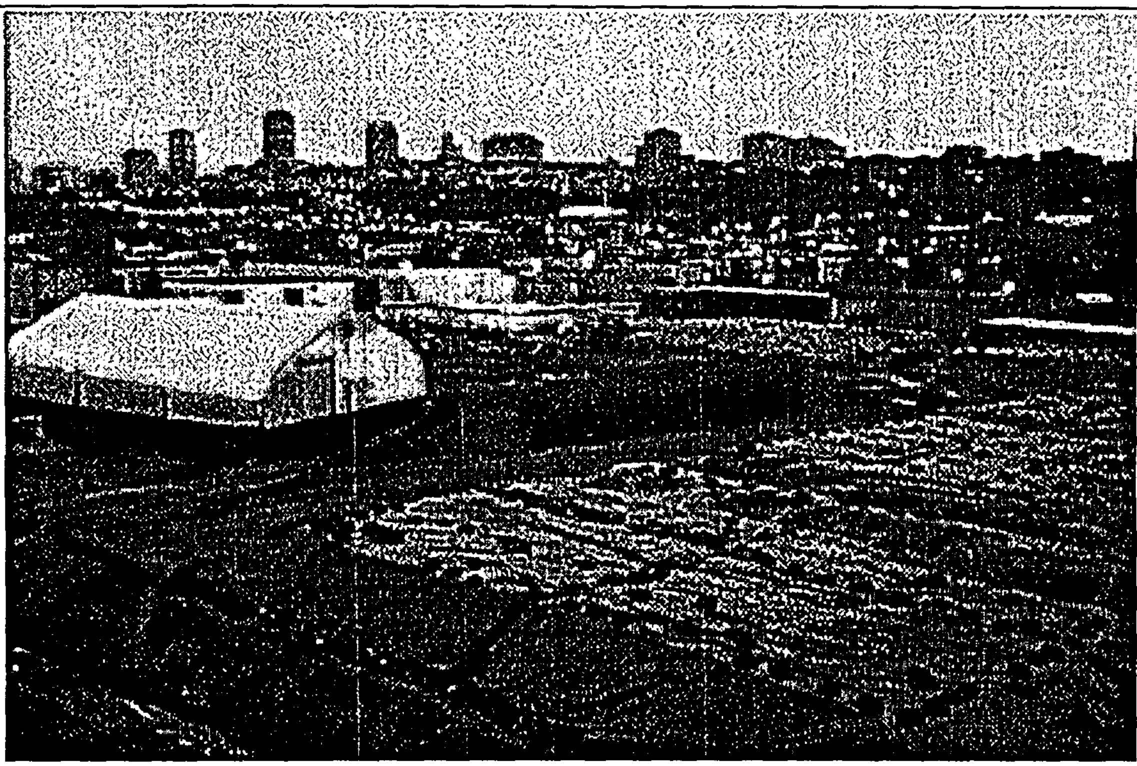
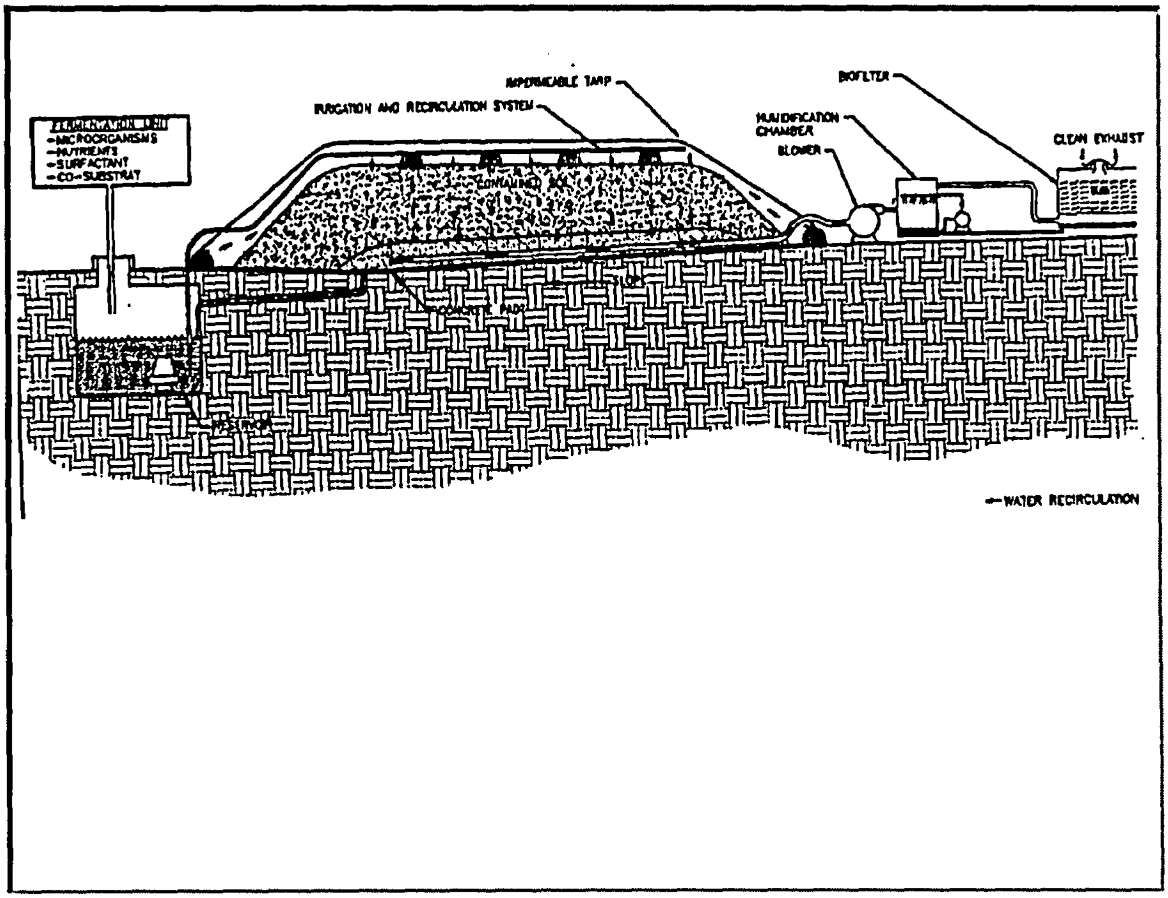
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Biogénie Biopile Process

19-Dec-97





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Biorem Inc., Biological Remediation of Contaminated Soil

19-Dec-97

TechID: 311

Technology Type: Biological

Contaminants Treated: PAH's, Petroleum Hydrocarbons, VOCs, BTEX, Explosives
DOP Plasticizers (Phthalate Esters).

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

Biorem utilizes advanced application technologies to accelerate the biodegradation of recalcitrant organic chemicals. In addition to the more readily biodegradable BTEX chemicals, Biorem will degrade TPH, PAH, PCP and pthalate ester plasticizers.

Scientific principles are used in biofeasibility studies to design the process and predict the performance. In this manner, successful results can be assured. Turnkey site remediation services are provided.

Biorem has successfully completed both in-situ and ex-situ remediation. Technologies applied include air sparging, soil venting, biopile construction and landfarming.

Limitations: Bioremediation is limited in applications for chlorinated organics. Process requires working space and takes time.

Efficiency Description: 90%

Government Funding:

Environmental Concerns: Volatilization of organics may need control.

Health & Safety Plan Available: ☒

Regulatory Approvals Ontario MOE and Massachusetts permits have been obtained.

Setup/Feed: Setup Time (days): 21 Breakdown Time (days): 21

Feed Rate Average (Tonne/hr): 3

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $60.00

Amount treated: 700 tonnes. Windrow turning equipment is leased. Working space is available on-site.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Biorem Technologies Inc.
450 Phillip St., Unit 11
Waterloo, ON
Canada N2R5J2
Notes

Contact: Herner, Brian
Phone: (519) 746-8973 Ext:
Fax: (519) 746-1222
Email:

Literature References:

Author: **Yu, Diaz-Diaz, Kunze and Ward**
Title: Biormediation of Phthalate Esters in Contaminated Soil
Journal: Proceedings 1993 Superfund Conference Washington, D.C. Date: **Dec 1993**

Author: **Kunze and Ward**
Title: Aerated Biopile Reduces Ethylbenzene Contamination in Industrial Soil
Journal: Environmental Science and Engineering Date: **Jan 1994**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Bird Engineering, HET Slurry Decontamination Process

19-Dec-97

TechID: 319

Technology Type: Biological

Contaminants Treated: PAH's, Oil & Grease

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

Based on the scientific foundation established by the Delft University of Technology DUT (1986-1994), BIRD Engineering further developed the "Slurry Decontamination Process" (SDP process) in the years 1992-1995. The SDP process is a new biotechnological process for the ex-situ treatment of excavated polluted soils and sediments. In cooperation with DUT, BIRD Engineering constructed and operated a 4.2 m^3 pilot plant to prove the technical and economical feasability of the SDP process. In addition to several batch experiments, in the pilot plant of the SDP process, two semi-continuous test runs were done with 3.3 ton oil polluted 'Mijdrecht' clay soil and 3.7 ton oil and PAH 'Petroleumhaven' sediment.

In the spring of 1995, another 10 tonne 'Petroleumhaven' was processed. Results showed that the 'Mijdrecht' clay soil was cleaned sufficiently, the oil concentration was below the Dutch reference value (former A-value) for soils. For the 'Petroleumhaven' sediment the overall efficiency for oil and PAH degradation, using a 16 days residence time, was respectively about 65% and 92%. Economic evaluation made clear that the cost price will vary in between 100 and 200 dfl/ton, depending on the solid characteristics, end quality and process operation. Since the pilot results matched the expectations, the process was commercialized in 1996.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $70.00

The feed rate and unit cost information hold true for a reactor scale of 1150 m^3 which at this time is under design (not yet built).

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

BIRD Engineering B.V.
de Brauweg 13
Schiedam, AE
The Netherlands 3125 -
Notes

Contact: Kleijntjens, R.
Phone: 010-415 78 22 Ext:
Fax: 010-437 96 48
Email:

Vendors:

BIRD Engineering B.V.
de Brauweg 13
Schiedam, AE
The Netherlands 3125 -
Notes

Contact: Kleijntjens, R.
Phone: 010-415 78 22 Ext:
Fax: 010-437 96 48
Email:

Literature References:

Author: **Kleijntjens, R.H.**
Title: Biotechnological Slurry Process for the Decontamination of Excavated Polluted Soil
Journal: Thesis Date: **Jan 1991**

Author: **Kleijntjens, R.H., Oostenbrink, I., Mijnbeek, G.**
Title: Development of the 'Slurry Decontamination Process'
Journal: Final Project Report (NOVEM) (in Dutch) Date: **Jan 1994**

Author: **Kleijntjens, R.H., Oostenbrink, I., Mijnbeek, G.**
Title: Application of the 'Slurry Decontamination Process' for Cleaning of Polluted Sediment from the Petroleumhaven Amsterdam
Journal: Date: Jan 1995

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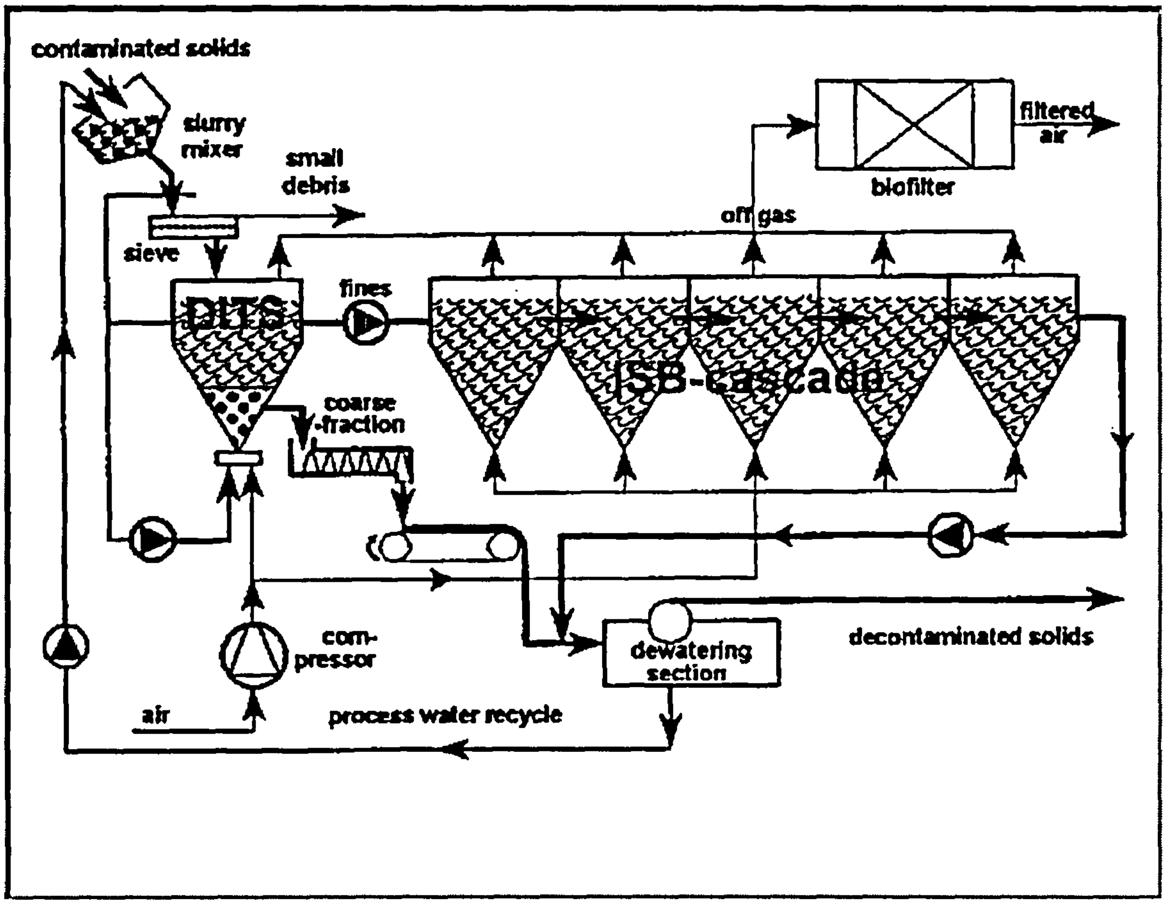
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Journal: Final Project Report (RIZA/POSW II) (in Dutch) Date: Jan 1995

Author: Oostenbrink, I.M., Kleijntjens, R.H., Mijnbeek, G., et al
Title: Biotechnological Decontamination of Oil and PAH Polluted Soils and Sediments Using the 4 m³ Pilot Plant of the "Slurry Decontamination Process"
Journal: TNO/KfK Conference in Maastricht Date: Nov 1995



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Bird Engineering, HET Slurry Decontamination Process

19-Dec-97

Project: Second Testing POSW/RIZA **Year: 95**

Location: Bench Scale

Client/Funding Agency	Contact	Phone
POSW/RIZA		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Tested Slurry Decontamination Process with underwater sediment (second testing). Done in cooperation with POSW/RIZA and two contractors.

Project: POSW/RIZA **Year: 94**

Location: Bench Scale

Client/Funding Agency	Contact	Phone
POSW/RIZA		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Tested Slurry Decontamination Process with underwater sediment. Done in cooperation with POSW and Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling (RIZA).

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Bos Engineering, Settling Basin Optimization

19-Dec-97

TechID: 320

Technology Type: Pre Treatment, Physical

Contaminants Treated: Pesticides/Herbicides, Heavy Metals, Mercury
Particulates

Media Treated: Sediment Ex-Situ, Suspended Sediments

Development Stage: Commercial **Country Of Origin:** Canada

Physical

Description:

The technology is the optimization of simple settling basins for removal of particulates either in-strean shape, flow path, baffling and outlet design are variables to be optimized to attain desired efficiency o:

The technology is ideal for dredge effluent particulate removal.

Limitations: Requires available land base for construction (varies with feed rate).

Efficiency Description: Can collect and sort sediments by size.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Certificate of Approval (Ministry of the Environment and Energy - Kingston).

Setup/Feed: Setup Time (days): 4 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 1025

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $250.00 – $1,000.00 Average Cost (US$/Tonne): $250.00

Note: Both feed rate and Unit cost are usually calculated per liter for this process and therefore quanitities per tonne could be distorted. Unit cost per liter ranges from $0.25 to $1.00 US.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solids; Water

Developers:

Bos Engineering and Environmental Services
46 Donnybrook Rd.
London, Ontario
Canada N5X3C8
Notes

Contact: Bos, A. W.
Phone: (519) 850-9987 Ext:
Fax: (519) 663-8057
Email:

Vendors:

Bos Engineering and Environmental Services
46 Donnybrook Rd.
London, Ontario
Canada N5X3C8
Notes

Contact: Bos, A. W.
Phone: (519) 850-9987 Ext:
Fax: (519) 663-8057
Email:

Literature References:

Author: **HSP Inc. - A.W.Bos for Voyageurs Marine Construction Co.**
Title: Sediment Dredging - Ingleside, Ontario, Canada : Settling Basin Design Report
Journal: Date: Apr 1995

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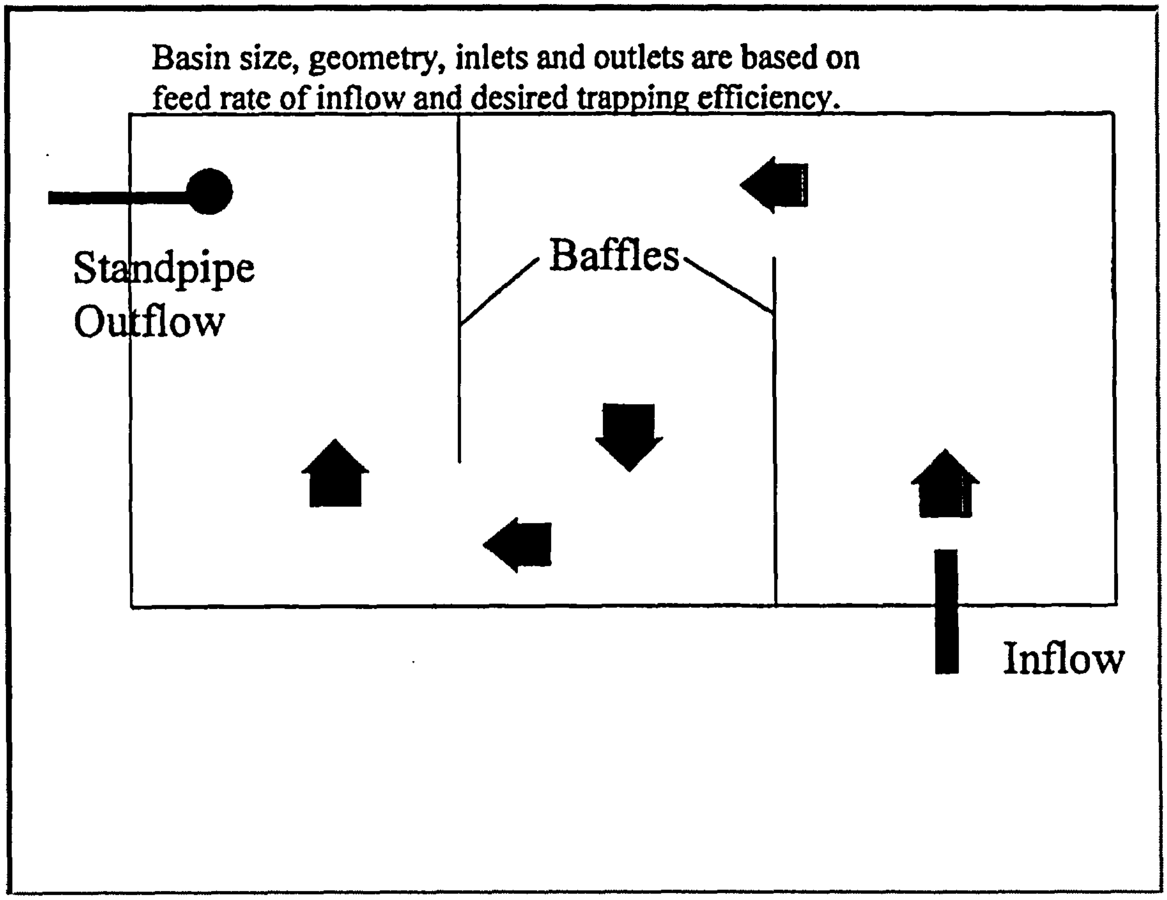

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Bos Engineering, Settling Basin Optimization

19-Dec-97

Project: Ingleside - Water Intake

Year: 95

Location: Ingleside, Ontario, Canada

Full Scale Demo

Client/Funding Agency	Contact	Phone
Voyageurs Marine Construction	Alex Kocsis	(514) 455-5678

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$): $30,000.00

Setup Time (days): 2

Breakdown Time (days): 2

Media Treated: Suspended Sediment

Contaminants Treated: Untreated level of suspended solids: 400 g/l or 4 x 10(5) mg/l. Removal efficiency: 99.5%.

Emissions/ByProducts:

Description: Amount treated: 100,000 m^3. Feed rate: 1000 m^3/hour.

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Bovar Retech Bioremediation

19-Dec-97

TechID: 161

Technology Type: Biological

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Bioremediation is one of the most cost effective technologies for those wastes that are biodegradable. The most common form of bioremediation is landfarming, but sediment is expected to be amenable to liquid/solids treatment (slurry form). Retech has successfully implemented bioremediation at several sites, including the first three Superfund sites to advance to full-scale bioremediation. Retech's patented bioventing and other innovative in-situ & ex-situ technologies have also been successfully employed at several superfund sites.

Limitations:

Efficiency Description: Up to 99%

Government Funding: Superfund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Approved, Superfund Sites, USEPA

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide and water

Developers:

Bovar Environmental Services
8563 Commerce Court
Burnaby, BC
Canada V7M 1A5
Notes

Contact: Chiricosta, Vince
Phone: (604) 444-3370 Ext:
Fax: (604) 984-3371
Email:

Vendors:

Remediation Technologies Inc.
1011 S.W. Klickitat Way, Suite 207
Seattle, WA
USA 98134-
Notes

Contact: Allworth, N.
Phone: (206) 624-9349 Ext:
Fax: (206) 624-2839
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Center for Hazardous Materials Research, Acid Extraction Treatment System

22-Dec-97

TechID: 8

Technology Type: Metal Extraction

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** USA

Metal Extraction

Description:

The first step in the AETS process is screening to remove coarse solids. These solids, typically grea requiring at most a simple rinse with water or detergent to remove smaller attached particles.

After coarse particle removal, the remaining soil is scrubbed in an attrition scrubber to break up agg contacted with acid (HCl) in the extraction unit. The residence time in the unit will vary depending on the soil type, contaminants and contaminant concentrations, but generally ranges between 10 to 40 minutes. The soil/extractant mixture is continuously pumped out of the mixing tank, and the soil and extractants are separated using hydrocyclones. The solids are piped to the rinse system, while the extractant is treated using a proprietary technology which removes the metals and regenerates the acid. The soils are rinsed with water to remove entrained acid and metals. CHMR anticipates a final step, not currently performed, in which the soils will be mixed with lime and fertilizer to neutralize any residual acid and return the soil to natural conditions.

Limitations: Cannot treat organics.

Efficiency Description: >90% removal of As, Cd, Cu, Ni, Pb and Zn

Government Funding: ETP

Environmental Concerns: Corrosive chemicals (HCl).

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 120 Breakdown Time (days): 90

Feed Rate Average (Tonne/hr): 20

Cost: Capital Cost (US$): $4,100,000.

Treatment Cost (US$/Tonne): $120.00 – $140.00 Average Cost (US$/Tonne): $130.00

All estimates.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Metals sludge.

Developers:

Center for Hazardous Materials Research
320 William Pitt Way
Pittsburgh, PA
USA 15238-
Notes

Contact: Paff, S.
Phone: (412) 826-5321 Ext: 233
Fax: (412) 826-5552
Email:

Vendors:

Center for Hazardous Materials Research
320 William Pitt Way
Pittsburgh, PA
USA 15238-
Notes

Contact: Paff, S.
Phone: (412) 826-5321 Ext: 233
Fax: (412) 826-5552
Email:

Literature References:

Author: Paff, S.W.
Title: Emerging Technology Summary: AETS for Treatment of Metal Contaminated Soils
Journal: EPA/540/57-94/513 Date: Aug 1994

Author:
Title: Two Technologies Studied for Reclaiming Lead from Superfund Sites
Journal: Hazardous Waste Consultant Date: Nov 1994

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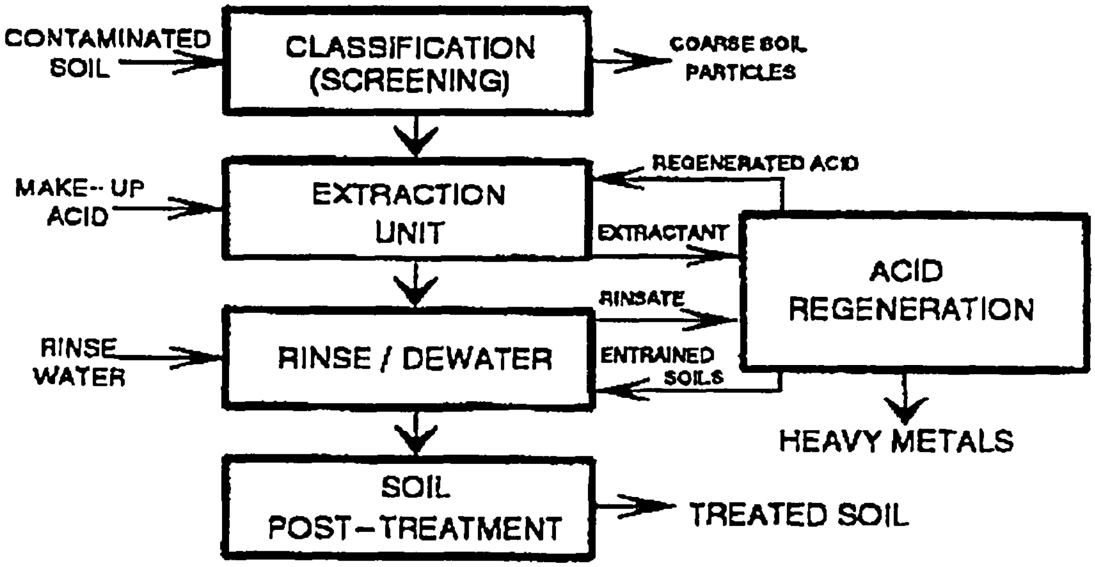
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Figure 1-1. AETS Block Flow Diagram.



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Ceramics Kingston Biochemical Process

22-Dec-97

43

Technology Type: Biological

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Heavy Metals

Biological

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada

1

Description:

The technology being proposed for development is designed to remove low level organic contamin contaminated sediment. The process involves biological degradation of the hydrocarbon contamin ions, fractional extraction of the heavy metal values and vitrification of any remaining and unwanted heavy metal ions. Extraction of heavy metal values from the fractionated solution will involve solvent extraction or membrane separation. Vitrification will utilize microwave technology developed by the company.

The decontaminated sediment can then be returned to the Great Lakes. The vitrified residue can be disposed in a landfill site.

The company plans to enter into collaborative agreements with CANMET and NRC with respect to the microbioligical aspects of the project.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: "Solid and liquid residues"

Developers:

Ceramics Kingston Inc.
P.O.Box 655
Kingston, Ontario
Canada K7L 4X1

Contact: Sood, R.
Phone: (613) 548-7253 Ext:
Fax: (613) 542-2856
Email:

Notes

Literature References:

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CET Bioremediation

22-Dec-97

Technology Type: Biological TechID: 190

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

BIOTA utilizes only the naturally occurring indigenous bacteria of the contaminated material for its bioremediation processes. Selected species are adapted and then returned to the soil with the appropriate inorganic and nutrient supplements. In-situ bioremediation involves flushing the soil with the prescribed solutions through pressure injection. Wells capture the contaminated groundwater and recirculate it with additional nutrients and/or organisms. On-site treatment involves either landfarming or the use of bioreactors on excavated materials.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water and biomass

Developers:

CET Environmental Services
3447 Atlantic Avenue, Suite 300
Longbeach, CA
USA 90807-
Notes

Contact: Young, Michael
Phone: (310) 427-5999 Ext:
Fax:
Email:

Vendors:

Sanivan Group, Inc.
3027 Harvester Rd., Unit 202
Burlington, Ontario
Canada L7N 3G7
Notes

Contact:
Phone: Ext:
Fax:
Email:

Literature References:

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CET Chemical Fixation and Solidification (CFS)

22-Dec-97

TechID: 203

Technology Type: Stabilization/Fixation

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Stabilization/ Fixation

Development Stage: Commercial **Country Of Origin:** USA

Description:

Toxco utilizes a two-part chemical system based on sulfides, silicates and silicate-setting agent le solids from waste matter. Soils, sludges, ash and baghouse dust can all be treated with this prc treatment technology.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 25

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$50.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

CET Environmental Services
3447 Atlantic Avenue, Suite 300
Longbeach, CA
USA 90807-
Notes

Contact: Young, Michael
Phone: (310) 427-5999 Ext:
Fax:
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CET Vapour Extraction System (VES)

22-Dec-97

TechID: 200

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA

Organic Extraction

Description:

Thorne's Vapour Extraction Systems are employed in-situ on soils for the removal of volatile o. vacuum at extraction wells, vapours containing the VOC are removed for treatment. The proce portable.

Treatment of the contaminated vapours can be undertaken with one or more of the following te ...., catalytic conversion, activated carbon and internal combustion.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

CET Environmental Services
3447 Atlantic Avenue, Suite 300
Longbeach, CA
USA 90807-

Contact: Young, Michael
Phone: (310) 427-5999 Ext:
Fax:
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CF Systems Solvent Extraction Technology

22-Dec-97

TechID: 38

Technology Type: Chemical, Metal Extraction, Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The treatment process developed by CF Systems is based on critical fluid extraction. Selected gases, liquified through application of pressure, are used as solvent to extract organics. Propane is used for sludges and solids, while carbon dioxide is used for wastewater streams. Once the solvent has extracted the organics from the waste it is vaporized and recycled leaving the organics for recovery or disposal and the treated material in a slurry or cake. The system runs as a continuous process for pumpable materials and a batch process for non-pumpable materials.

The solvent extraction process is applied on a commercial scale with the Mobile Pit Cleaning Unit (PCU) and on a demonstration scale, with the Mobile Demonstration Unit (MDU). Extraction of PCBs, dioxins, PAHs and PCPs from harbour sediment has been successfully demonstrated by both units.

Limitations: Requires prescreening of oversize material (greater than 1/2 ").

Efficiency Description: PCBs: 98%-99.9% in the lab, 90%-98% in the field; PAHs: >99%

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals U.S. EPA approved

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 4

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$150.00 – $450.00** Average Cost (US$/Tonne): **$300.00**

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Decontaminated slurry stream and concentrated contaminants for recovery or disposal.

Developers:

CF Systems
3D Gill Street
Woburn, MA
USA 01801-
Notes

Contact: Shallice, Chris
Phone: Ext:
Fax:
Email:

Literature References:

Author: **CF Systems**
Title: CF Systems Organics Extraction Process New Bedford Harbor, MA
Journal: US EPA 540/A5-90/002 Date: **Aug 1990**

Author: **CF Systems**
Title: CF Systems Solvent Extraction Treatability Studies
Journal: Internally Generated Documents Date: **Sep 1992**

Author: **CF Systems**
Title: Site Remediation of Contaminated Soils and Sediments
Journal: Internally Generated Documents Date: **Sep 1992**

Author: **Markiewicz, J.**
Title: Use of Solvent Extraction to Treat Soils and Sludges
Journal: Superfund 92 Date: **Oct 1992**

Author: **Shallice, C.**
Title: Post SITE Program Update
Journal: Fourth Forum on Innovative Hazardous Waste Treatment Technologies Date: **Oct 1992**

Author: **CF Systems**
Title: Treatment of PCB Contaminated Soils with CF Systems SX Technology
Journal: Date: **Aug 1993**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CF Systems Solvent Extraction Technology

Journal: ACS-Emerging Technology Conference, Atlanta, GA, USA

Date: Aug 1993

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CF Systems Solvent Extraction Technology

22-Dec-97

Project: Star Enterprises, Refinery — **Year: 92**

Location: Port Arthur, Texas, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Star Enterprise	Joe Pitman	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 15000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:

Contaminants	Untreated:	Treated:
Benzene	40	1
Xylenes	300	1
Naphthalene	150	2
Phenanthrene	200	1
Pyrene	15	0.8
Phenols	10	2

Emissions/ByProducts:

Description:

Project: Waterways Experiment Station — **Year: 89**

Location: Vicksburg, Mississippi, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Litwin Engineers	Calvin Spencer	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Contaminants	Untreated:	Treated:
Benzene	8	0.5
Xylenes	130	0.26
Acenaphthene	2.2	
Anthracene	3.4	
Benzo(a)pyrene	2.3	
Chrysene	9.4	0.63
Fluorene	11.8	
Naphthalene	41	0.56
Phenanthrene	37	0.72
Pyrene	11	1.3

Emissions/ByProducts:

Description:

Project: New Bedford Harbour — **Year: 88**

Location: New Bedford Harbor, Massachusetts, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Vermont Agency of Natural Resources	Richard Valentinetti	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 5

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:

Contaminants	Untreated:	Treated:
PCB's	500	50

Emissions/ByProducts:

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~~Emissions/ByProducts:~~

Description:

Project: Norwood Superfund Site

Year:

Location: Norwood, Massachusetts, USA

Bench Scale

Client/Funding Agency	Contact	Phone
Metcalf & Eddy	Ms. Barbara Weir	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated:

Contaminants	Untreated:	Treated:
PCB's	1000	0.8

Emissions/ByProducts:

Description:

Project: United Creosoting Co., Inc.

Year:

Location: Conroe, Texas, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Texas Water Commission	Ms. LaReine K. Pound	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 100000

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated:

Contaminants	Untreated:	Treated:
Dioxins	1	
Pentachlorophenol	33	13
Acenaphthene	150	1.75
Chrysene	75	4
Fluorene	50	0.9

Emissions/ByProducts:

Description:

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Chem-Security Stabilization

22-Dec-97

TechID: 45

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

CSL experience has indicated that although many of the stabilization additives available are effective; combinations of cement, kiln dust, lime and fly ash are usually sufficient and less costly. Of course, additional additives will also be evaluated during treatability tests.

Limitations:

Efficiency Description:

Government Funding: DESRT

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Approved by the Government of Alberta

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Chem-Security
Box 180
Swan Hills, AB
Canada T0G2C0
Notes

Contact: Vetro, Paul
Phone: (403) 333-4197 Ext:
Fax: (403) 333-4196
Email:

Literature References:

Project: Pacific Place Site **Year: 93**

Location: Vancouver, British Columbia Bench Scale

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Metals; Organics

Emissions/ByProducts:

Description: Soil was screened through 100 and 200 mm mesh sieves, dried, and homogenized before adding the stabilization reagents. Following an initial screening process using six different formulations, the optimum weights of soil, cement, and admixtures (an approximate ratio of one part Portland cement and stabilizers and two parts soil) were combined with sufficient water to make a cement slurry. The material was then mixed in a blender, placed in molds, tamped, and allowed to cure for 26 days. This technology project was also participated in by Bovar Environmental Services.

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Cintec Environment Inc., Ogden CBC (Circulating Bed Combustor)

22-Dec-97

TechID: 139

Technology Type: Incineration

Contaminants Treated: PCB's, Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Incineration

Development Stage: Commercial **Country Of Origin:** Canada

Description:

The OGDEN - CBC waste treatment fluid bed incinerator can accept liquids, solids, soils, or sludg
dioxide, water and other non-toxic gases. It is designed for the destruction of hydrocarbons, PCB'
best available gas cleaning equipment, including dry scrubber process.

Limitations:

Efficiency Description: 99.9999 %

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals EPA

Setup/Feed: Setup Time (days): **15** Breakdown Time (days): **15**

Feed Rate Average (Tonne/hr): **2**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: At 7% O2 dry: part. < 50mg/Nm³, HCL < 75 mg/Nm³, SO2 < 200mg/Nm³, CO < 70 ppmV, TCDD < 5 ng/Nm³

Developers:

Cintec Environment Inc.
2401 Lapierre St.
LaSalle, PQ
Canada H8N1B7
Notes

Contact: Guerin, P.
Phone: (514) 365-4465 Ext:
Fax: (514) 365-2964
Email:

Vendors:

Cintec Environment Inc.
2401 Lapierre St.
LaSalle, PQ
Canada H8N1B7
Notes

Contact: Guerin, P.
Phone: (514) 365-4465 Ext:
Fax: (514) 365-2964
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CleanSoils, Thermal Desorption

22-Dec-97

Technology Type: Thermal TechID: 276

Contaminants Treated: Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Canada **P--t-ble:** ☐

Description:

CleanSoils standard low temperature Thermal Desorber equipment is designed to treat soil Thermal ;, and similar non-chlorinated hydrocarbons. CleanSoils' higher temperature Thermal Desorber ca oily solids, and polyaromatic hydrocarbons having boiling points below about 550 °C. Thermal with other technologies such as post treatment of filter cake from dewatered sludges.

The CleanSoils Thermal Desorber is a stand alone processing unit for treating solid materi he basic system fits on four trailer loads. Set-up time is approximately 2 days and about 150 ft. by 1 t mobile project sites, CleanSoils operates its own power generation and fires on liquid propane. Th out 30 GPM of water is required for rewetting soils for dust control and soil workability.

Soil throughput rates range from 30 to 70 tonnes per hour depending on the size of the unit, soil type, debris loading, moisture content, contamination and slean-up criteria.

CleanSoils Ltd. operates a fixed-base soil remediation centre in Hamilton, Ontario. The facility operates 24 hours per day, receiving soil from large & small projects in south-central Ontario.

Limitations: Cleansoils Thermal Desorber appropriate for hydrocarbon/VOC contaminated sediments if mechanical (or other) dewatering to maximum 20-25% moisture.
Low temperature thermal desorption appropriate for petroleum hydrocarbons & distillate with bp/vapourization temperature less than 900 F.

Efficiency Description:

Government Funding:

Environmental Concerns: Operating plant includes continuous monitoring & recording of CO, O2 & temperature.

Health & Safety Plan Available: ☒

Regulatory Approvals Ham. Har. Centre : MOEE C. of A. A100314 & 8-2133-92-006
Portable : C. of A. A130220; A 821001; 8-3213-92-006

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 125

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $25.00 – $50.00 Average Cost (US$/Tonne): $40.00

Contaminant: TPH and BTEX.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Vendors:

CleanSoils Inc.
3600 Labore Rd., Suite 1
Vadnais Heights, MN
USA 55110-
Contact: Poucher, James K.
Phone: (612) 483-4500 Ext:
Fax: (612) 483-4600
Email:
Notes This vendor serves West, Central and Southern USA.

Clean Soils Ltd.
225 Sheppard Ave., W.
North York, ON
Canada M2N1N2
Contact: Weis, Gordon M.
Phone: (416) 226-3838 Ext:
Fax: (416) 226-2931
Email:
Notes This vendor serves Canada and Great Lakes region of USA.

Literature References:

Author: **US EPA - Office of Emergency & Remedial Response**
Title: Thermal Desorption Treatment
Journal: Engineering Bulletin
Date: **May 1991**

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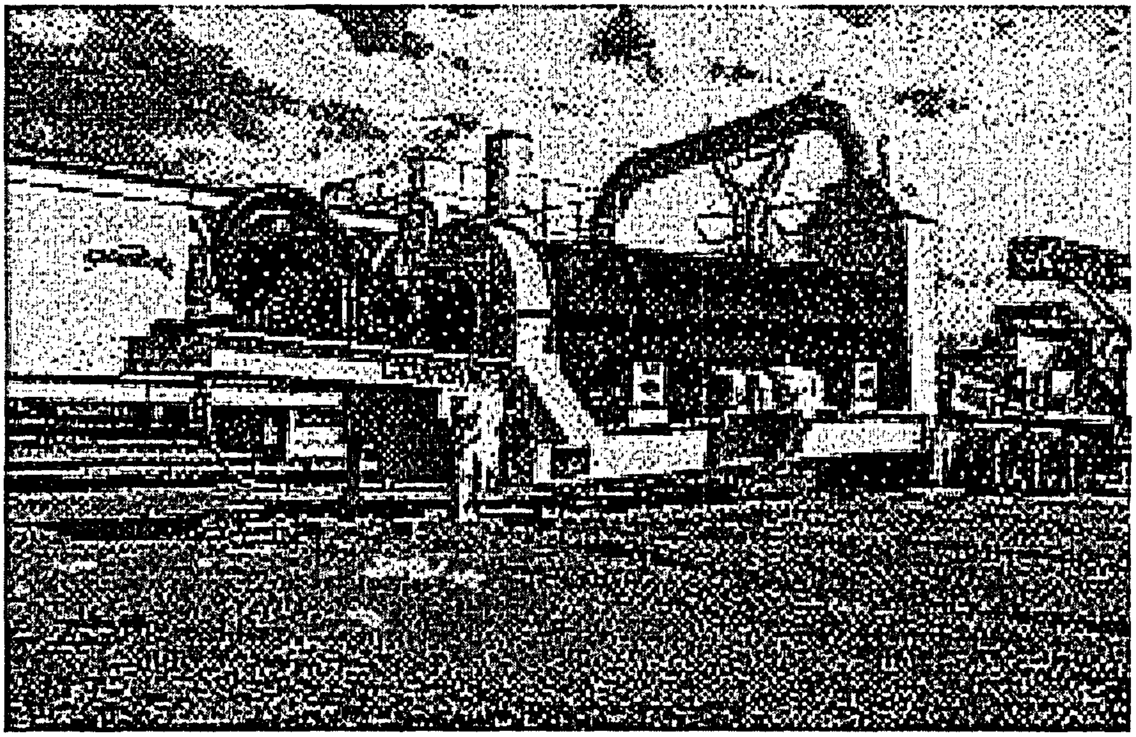
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CleanSoils, Thermal Desorption

22-Dec-97

Author: **Broussard-Weltha, P.**
Title: Thermal Desorption meets BDAT Standards at Louisiana Refinery
Journal: Oil & Gas Journal
Date: **Nov 1992**

Author: **Troxlor, Cudahy, Zink, Yezzi, Rosenthal**
Title: Treatment of Non-hazardous Petroleum-Contaminated Soil by Thermal Desorption Technologies
Journal: Air & Waste Journal
Date: **Nov 1993**



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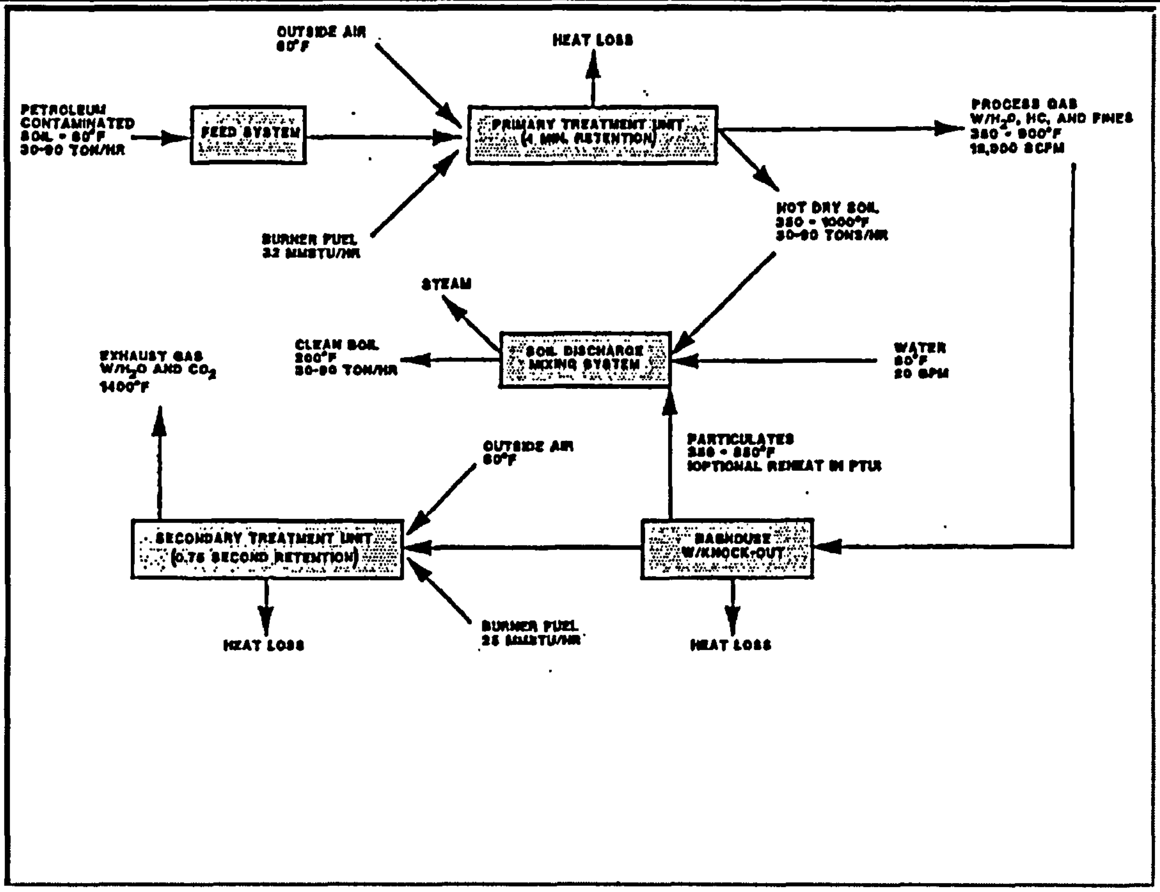
CleanSoils, Thermal Desorption



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CleanSoils, Thermal Desorption

22-Dec-97

Project: Retail Gasoline Station Soil Contamination — **Year: 95**

Location: Hamilton, Ontario — Commercial

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated:
Contaminants Treated: BTEX, TPH
Emissions/ByProducts:
Description: Contaminated soil transported to Hamilton site (from Toronto); staged on-site & thermally treated. Soil contaminated from leaking UST.

Project: Oil Pipeline Soil Contamination — **Year: 95**

Location: Hamilton, Ontario — Commercial

Client/Funding Agency	Contact	Phone
Site owner		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated:
Contaminants Treated: TPH
Emissions/ByProducts:
Description: Contaminated soil from pipeline spill transported to Hamilton site, staged and thermally treated

Project: Aviation Fuel Soil Contamination — **Year: 95**

Location: St.Paul, Minnesota — Commercial

Client/Funding Agency	Contact	Phone
Commercial		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated:
Contaminants Treated: BTEX
Emissions/ByProducts:
Description: Soil contaminated by AST leak/spill, delivered to fixed base, staged and themally remediated.

Project: Railway Lands Soil Contamination — **Year: 95**

Location: Hamilton, Ontario — Commercial

Client/Funding Agency	Contact	Phone
Commercial		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days):
Breakdown Time (days):
Media Treated:
Contaminants Treated: TPH
Emissions/ByProducts:

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CleanSoils, Thermal Desorption

22-Dec-97

Description: Soil contaminated from past/historic railway operations recovered, staged and thermally treated. Cleaned soil, recycled, and returned to originating site.

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Cognis Terramet Metal Leaching Technology

22-Dec-97

TechID: 277

Technology Type: Chemical, Metal Extraction, Physical, Soil Washing/Volume Reduction

Contaminants Treated: Heavy Metals, Radionuclides, Mercury

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The Cognis Terramet System is a process which physically scrubs the surface of soil particles, removes discrete metal particles by density or magnetic separation, and leaches or dissolves the remaining heavy metal contaminants. The metals are recovered and recycled. The plant is trailer mounted and portable. Because of the size of the plant a minimum job size is approximately 5,000 tons.

* Soil washing/leaching can reduce metal concentrations by >95%.
* The process does not generate any hazardous waste by-products.
* The process has been proven full-scale at a 20,000 ton site.
* Technology evaluated in US SITE Emerging and Demonstation Programs.
* Process is aqueous-based with no dust generation.

Limitations: Does not treat organics in general.

Efficiency Description: Can achieve up to 95% removal of metals.

Government Funding: Great Lakes Cleanup Fund, SITE

Environmental Concerns: None

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): **14** Breakdown Time (days): **14**

Feed Rate Average (Tonne/hr): **19**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$100.00 – $200.00** Average Cost (US$/Tonne): **$185.00**

Contaminant: Lead / Initial level : >2000 ug/g dry / Final level : <200 ug/g dry / Total amount treated : 10,000 tonnes / Other metals are removed. If a mixture of metals, price is toward high end of price range ($200/tonne); if single metal, price is lower ($100/tonne).

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products:

Developers:

Cognis, Inc.
2331 Circadian Way
Santa Rosa, CA
USA 95407-
Notes

Contact: Fristad, Bill
Phone: (707) 576-6235 Ext:
Fax: (707) 575-7833
Email: fristadb@cognis.com

Vendors:

Cognis, Inc.
2331 Circadian Way
Santa Rosa, CA
USA 95407-
Notes

Contact: Fristad, Bill
Phone: (707) 576-6235 Ext:
Fax: (707) 575-7833
Email: fristadb@cognis.com

Literature References:

Author: **Fristad, William**
Title: Sediment Remediation Investigation Phase I and II Treatability Studies: WTC-COSTTEP: St. Marys River, Bellevue Park
Journal: Site, Sault Ste. Marie, Ontario
Date: **May 1993**

Author: -,-
Title: Metal leaching and recovery process demonstrated for contaminated soil
Journal: Hazardous Waste Consultant
Date: **Nov 1993**

Author: **Benker, Keith**
Title: Treating Metals in soil
Journal: The Military engineer
Date: **Nov 1994**

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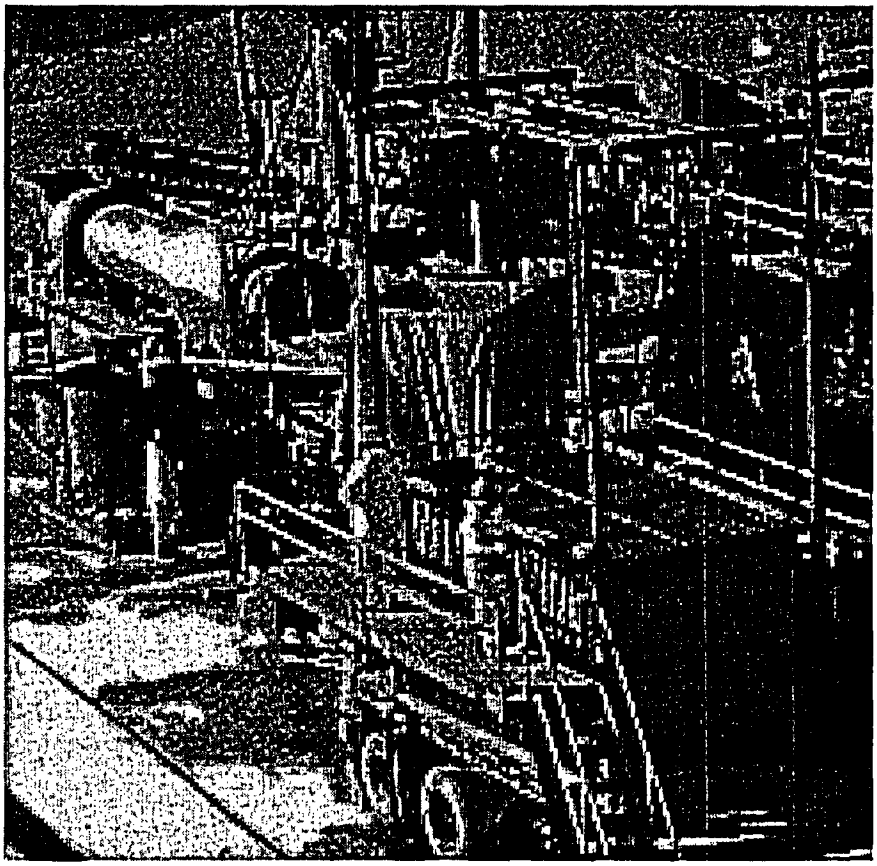
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Cognis Terramet Metal Leaching Technology

22-Dec-97

Author: **Fristad, William**
Title: Case Study Using Soil Washing/leaching for the removal of heavy metal at the Twin Cities Army Ammunition Plant
Journal: Remediation
Date: **Sep 1995**



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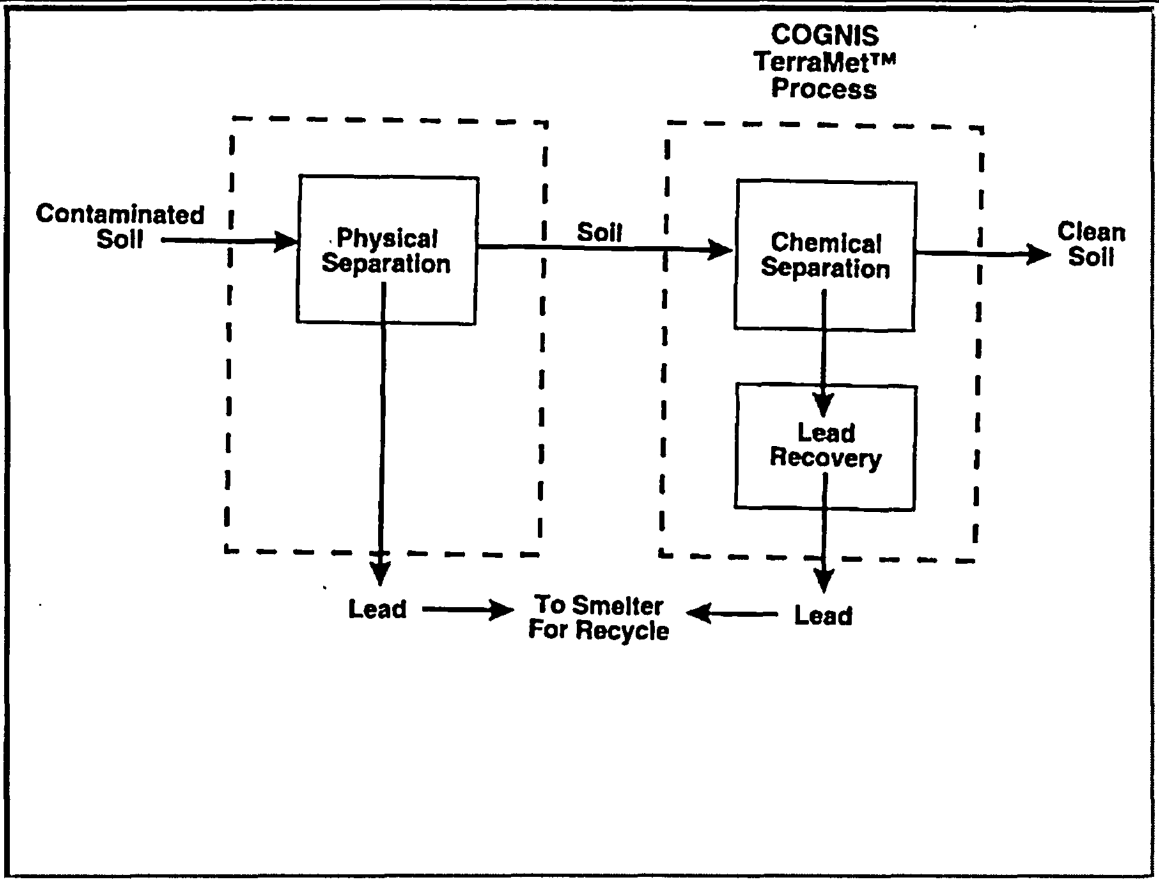

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Cognis Terramet Metal Leaching Technology

22-Dec-97

Project: Twin Cities Army Ammunition Plant (TCAAP) **Year: 93**

Location: New Brighton, MN Commercial

Client/Funding Agency	Contact	Phone
US Army	Marty McCleery	(612)633-2301

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Lead, Copper

Emissions/ByProducts:

Description: A soil washing/leaching operation. All excavated soil was treated in the plant. Heavy metals were removed from all soil fractions (gravel, sand, fines) and all soil fractions were returned on-site. At the end of the season, process water was treated in the plant to sanitary sewer discharge criteria.

Project: St. Marys River Bellevue Park **Year: 92**

Location: Sault Ste. Marie, Ontario, Canaa Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	Craig Wardlaw	(905) 336-6460

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.03

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. The sample (30.9 kg) in two buckets contained standing water. The sediment was separated into water and wet solids fractions by settling and decantation. The sediment was very dark and fine textured with no large rock or debris. The sediment smelled strongly of decaying vegetation. The solids were allowed to air dry, then dried at 80C prior to detailed physical and chemical characterization. The dry weight of the sediment was 16.1 kg.

Contaminants Treated: Heavy Metals. See Table.

Emissions/ByProducts:

Description: Testing of COGNIS TerraMet metal leaching recovery process at the bench scale for St Marys River sediment. COGNIS performed Phase I and Phase II treatability studies.

RESULTS
The results of the Phase I study revealed that coupling a magnetic separation pre-treatment step with the leaching could give satisfactory removal of the heavy metal contaminants. Phase II verified thses findings and also added the step of metal recovery from the loaded leachant to complete the process.
COGNIS pretreatment and leaching of the sediment reduced the heavy metal concentration substantially. Concentrations of all the heavy metals except iron wre quite low initially; nonetheless, metal concentrations after treatment have been reduced to near or below the Draft Ontario In-Place Sediment Criteria for Lowest Effect Level. The leaching results summarized in the table were performed on whole magnetically pre-treated sediment.

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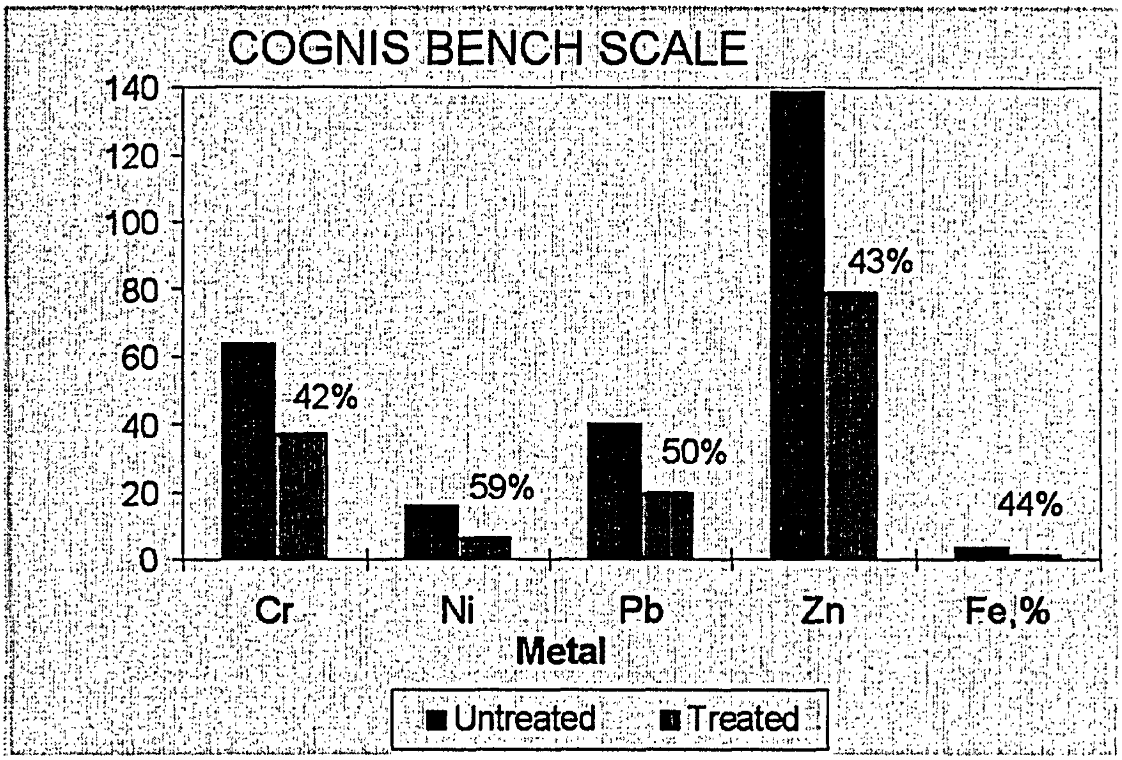

Phase I Results:

Metal Concentration, US-EPA Acid Digestion (ppm)				
Metal	Initial	Treated	Ontario Lowest Effect Level	Percent Removal
Iron	35800	13400	20000	63
Chromium	64	34	26	47
Nickel	15.7	8	16	45
Lead	40	6	31	84
Zinc	139	44	120	68

Phase II Results:

Metal Concentration, US-EPA Acid Digestion (ppm)				
Metal	Initial	Treated	Ontario Lowest Effect Level	Percent Removal
Iron	35800	15600	20000	44
Chromium	64	37	26	42
Nickel	15.7	6.5	16	59
Lead	40	20	31	50
Zinc	139	79	120	57

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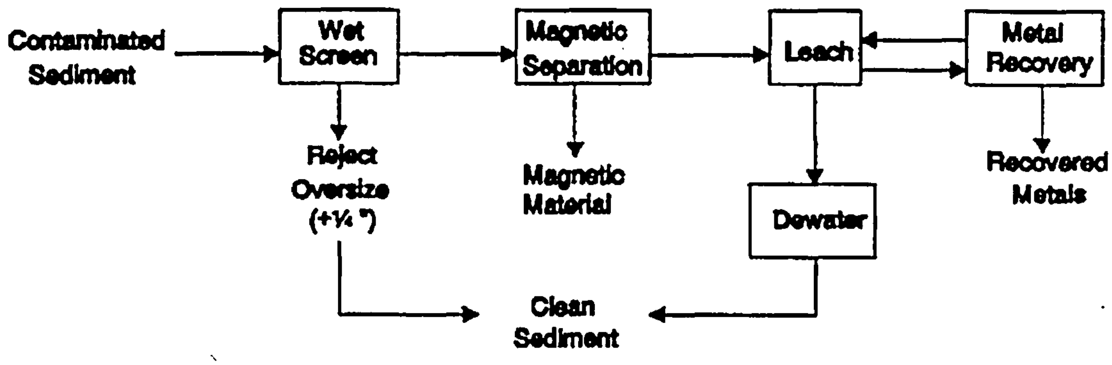
Cognis Terramet Metal Leaching Technology 22-Dec-97



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Colloid Sorbond Solidification

22-Dec-97

TechID: 183

Technology Type: Stabilization/Fixation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

This technology may be applied to the immobilization of organics, inorganics and radioactive wastes using the waste specific solidification agent SORBOND. SORBOND contains proprietary minerals and silicates and can be formulated for specific contamination with organophilic clays and other agents. Resultant solid passes TCLP and solidification testing parameters.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Approved technology in USA

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$40.00 – $270.00** Average Cost (US$/Tonne): **$155.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: All contaminants remain in solid

Developers:

Colloid Environmental Technologies Company
1500 West Shure Drive
Arlington Heights, IL
USA 60004-
Notes Additional Contact: J. Ashton

Contact: Excell, D.
Phone: (708) 392-4600 Ext:
Fax: (708) 506-6199
Email:

Vendors:

Ontario Pressure Products Ltd.
P.O. Box 123
London, Ontario
Canada N6A 4V6
Notes

Contact: Ross, A.
Phone: Ext:
Fax:
Email:

Literature References:

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Comrie Inorganic Binders

22-Dec-97

TechID: 49

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

This technology chemically or physically binds contaminants. Aluminum-silicate oxides and polysilicates react in alkali conditions to form "geopolymers". In general, the "geopolymers" physically stabilize the contaminants, heavy metals may stabilize chemically. As the waste material/chemical mixture ages, the "geopolymer" solidifies.

The resulting solids possess high early strength (75% of 28 day strength by 2 days), high ultimate strengths (compressive and flexural), very low shrinkage, high freeze-thaw resistance, high corrosive resistance, high resistance to chemical leaching, and long term stability. Wastes containing heavy metals, cyanides, arsenic, oils, greases, low level radioactive elements and sulphur dioxide, have been successfully processed.

Limitations:

Efficiency Description: Varies with waste processed and contaminant concentration

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Various regulatory approvals in place.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 6

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $50.00 – $200.00 Average Cost (US$/Tonne): $125.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solid mass containing chemically altered contaminants

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Coreco, Rotary Kilns

22-Dec-97

Technology Type: Thermal, Chemical, Incineration, Stabilization/Fixation, Metal Extraction, Organic Extraction, Post Pre Treatment, Vitrification, Physical TechID: 300

Adsorption; Ion exchange

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs, BTEX, Explosives

Activated Carbon

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Indirectly heated high temperature rotary kiln with complete air pollution control accessories and material handling system.

Limitations: Corrosives; Temperatures in excess of 1,000°C.

Efficiency Description: 97% for 10,000 tonnes removing heavy metals.

Government Funding:

Environmental Concerns: No problem for applicable processes.

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 25

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $10.00

Assuming Contaminant BTEX, initial level 200 ug/g dry; final level <5 ug/g dry. Average feed rate 125-240 t/day.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

College Research Corp. (CORECO)
P.O.B. 577
Germantown, WI
USA 53022-
Notes

Contact: Evans, M.
Phone: (414) 255-4700 Ext:
Fax: (414) 255-5283
Email:

Vendors:

College Research Corp. (CORECO)
P.O.B. 577
Germantown, WI
USA 53022-
Notes

Contact: Evans, M.
Phone: (414) 255-4700 Ext:
Fax: (414) 255-5283
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CWM Chem-Matrix Stabilization/Solidification

22-Dec-97

TechID: 44

Technology Type: Stabilization/Fixation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Chem-Matrix is CWM's commercial automated process for the controlled mixing of waste and stabilization reagents. The process unit is a transportable, modified pugmill stabilization plant which is designed to mix solid or semi-solid materials with a dry stabilizing agent and water. The system can also be used to stabilize liquid waste. A modular design to allows for modification depending on specific project needs.

The system has been designed, tested, and demonstrated on a variety of metal bearing Resource Conservation and Recovery Act (RCRA) wastes. The process product meets Toxic Substances Control Act (TSCA) and RCRA regulation standards for leachability tests.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Chem-Matrix stabilization has been permitted for both fixed base and on-site projects in the US.

Setup/Feed: Setup Time (days): 10 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 12.5

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Stabilized solid with granular soil-like texture.

Developers:

Chemical Waste Management, Inc.
3001 Butterfield Road
Oak Brook, IL
USA 60521-

Contact: Fitzpatrick, R.
Phone: (708) 218-1678 Ext:
Fax: (708) 218-1511
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CWM DeChlor/KGME Process

22-Dec-97

TechID: 58

Technology Type: Chemical

Contaminants Treated: PCB's, Pesticides/Herbicides

Media Treated: Sediment Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

CWM's DeChlor/KGME is a batch process proposed as an alternate chemical dehalogenation technology to alkaline metal hydroxide/polyethylene glycol (APEG) and potassium polyethyleneglycol (KPEG). The process is designed to be applied to liquid concentrates such as would be obtained by thermal desorption.

The main advantage of CWM's process over other dehalogenation processes is claimed to be a saving in reagents quantities and hence costs.

The reaction of 2-methoxyethanol with either KH or KOH in an aprotic solvent results in the formation of the potassium derivative KGME. KGME reacts with haloaromatics, replacing one or more halogens with 2-methoxyethoxy functionality. The reaction takes approximately 3 to 6 hours to run to completion at a temperature of approximately 100 degrees Celsius. A nitrogen atmosphere is maintained in the reactor headspace for safety.

The pilot unit requires approximately 35 m^3 of land area. Compressed air, water (city supply) and electricity (3phase, 460V, 100A) are required for operation.

Limitations:

Efficiency Description: >99.8% achieved at bench and pilot scale

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.006

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Chemical Waste Management, Inc.
1950 South Batavia Avenue
Geneva, IL
USA 60134-3310

Contact: Ayen, R. J.
Phone: (708) 513-4500 Ext:
Fax: (708) 513-0087
Email:

Notes

Literature References:

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CWM Enrac Fuels Conversion System

22-Dec-97

TechID: 72

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The ENRAC Fuels Conversion System was designed as a mass reduction technology for refinery filter cakes. It can also be used to remove organics from solids and sludges. It uses a steam or oil heated indirect dryer. This is attached to a 3 stage vapor control system. The vapor control system is comprised of a direct contact cooler/absorber, a refrigerated condenser and a carbon absorption system.

Limitations:

Efficiency Description: Depends on contaminant

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Usually requires only air permit

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 0.75

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $100.00 – $200.00 Average Cost (US$/Tonne): $150.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: 1. Dried, organic free solids. 2. Small, nominal organic emissions typically less than 0.01 lbs/day.

Developers:

Chemical Waste Management, Inc.
3001 Butterfield Road
Oak Brook, IL
USA 60521-
Notes

Contact: Schleck, D.
Phone: (708) 218-1500 Ext:
Fax: (708) 573-0757
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

CWM PO*WW*ER Treatment System

22-Dec-97

TechID: 149

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Suspended Sediments

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The process is a unique advanced waste-water evaporator technology integrated with a proprietary catalytic oxidizer. The unit accepts a broad range of waste-waters contaminated with both organic and inorganic materials. It destroys a wide range of organic compounds including ammonia, cyanides (and related nitrogen compounds), reduced sulfur compounds and halogenated compounds. In the evaporative process it removes inorganics and heavy metals in a concentrated brine that may be suitable for disposal directly or after secondary stabilization treatment. The PO*WW*ER forced-circulation evaporator does not require chemical additives (except in some cases for pH adjustment). Volatile organic compounds are volatilized and destroyed in the catalytic oxidizer.

Limitations:

Efficiency Description: 99.99%+ depending on contaminant and concentration

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals PO*WW*ER has been operated with all required permits and in compliance with all applicable regulations.

Setup/Feed: Setup Time (days): 90 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.004

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Normal oxidation gases. Concentrated and fully or partially concentrated brine. Extremely clean water effluent.

Developers:

Chemical Waste Management, Inc.
3001 Butterfield Road
Oak Brook, IL
USA 60521-
Notes

Contact: Herbst, S.
Phone: (708) 218-1500 Ext:
Fax: (708) 218-1511
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Davy Intl In-Pulp Extraction Process

22-Dec-97

Technology Type: Metal Extraction TechID: 108

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Metal Extraction

Development Stage: Pilot Scale **Country Of Origin:** Englanc rtable: ☒

Description:

The In-pulp Extraction Process is based on the resin-in-pulp (RIP) and carbon-in-pulp ((rated commercially for the recovery of metal from ore. Due to the mining application, all equ ge is most appropriate for metals extraction, while CIP is most appropriate for the extraction of org

Sediment is screened to remove oversize material and the resultant fines slurry is transported to a well mixed reactor for chemical solubilization of the metals. The leached slurry (pulp) is contacted with an ion exchange resin to extract the metals from solution. The resin may be regenerated resulting in a concentrated solution of metals. For organic contaminants, a similar process occurs however the leaching chemicals are different and the carbon is regenerated by thermal desorption.

The key to this process is the proprietary counter-current RIP/CIP contactor. Contaminated slurry flows continuously in one direction through screens which separate each stirred stage containing up to 25% resin or adsorbent. The resin is retained in the contactor by air swept screens which separate the stages. The resin is moved counter-current to the slurry flow using an air lift system which transfers the resin from stage to stage.

Limitations: May have trouble treating mixtures of contaminants. Not effective on all sediments.

Efficiency Description: Up to 87% removal has been achieved.

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean fine solids, washed oversize solids, metals sludge (or concentrated organics)

Developers:

Davy Energy & Environmental
Ashmore House
Stockton-on-Tees, Cleveland
England TS18 3RE
Notes

Contact: Wightman, G.
Phone: (0642) 602221 Ext:
Fax: (0642) 341001
Email:

Vendors:

Davy Canada, Inc.
Suite 1800, 480 University Avenue
Toronto, Ontario
Canada M5G 1V2
Notes

Contact: Thom, Ian
Phone: (416) 340-1145 Ext:
Fax: (416) 343-9300
Email:

Literature References:

Author: **Wightman, G.**
Title: Bench Scale Demonstration: In-Pulp Treatment of Hamilton Harbour Sediment
Journal: Prepared for Great Lakes Cleanup Fund Date: Apr 1994

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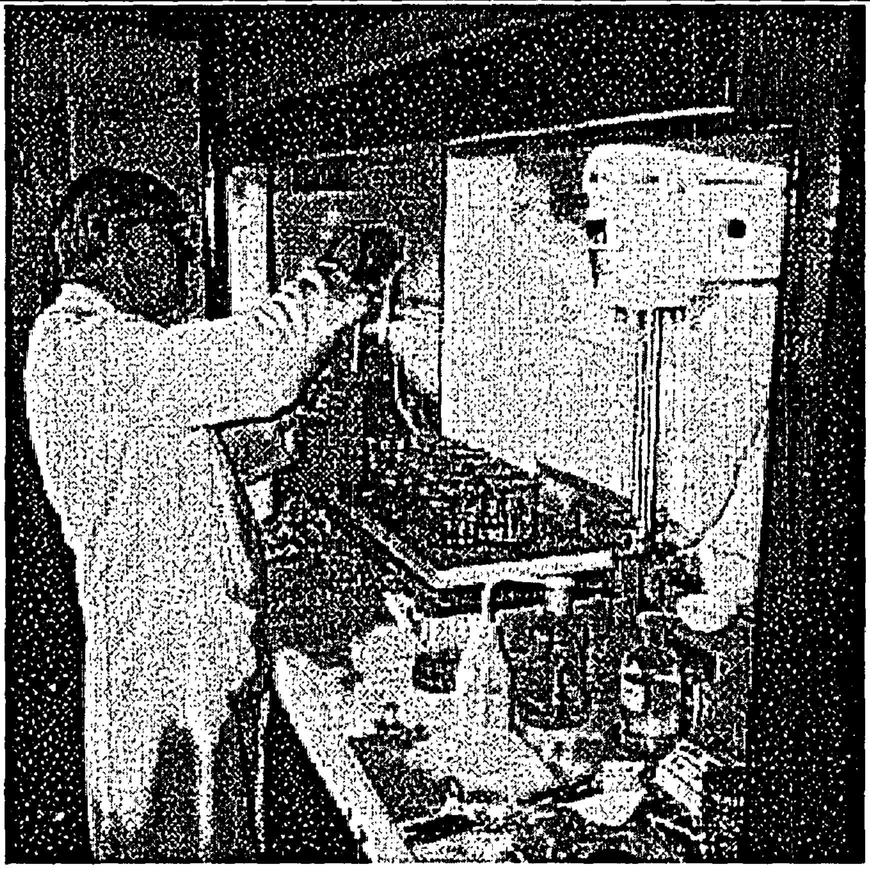
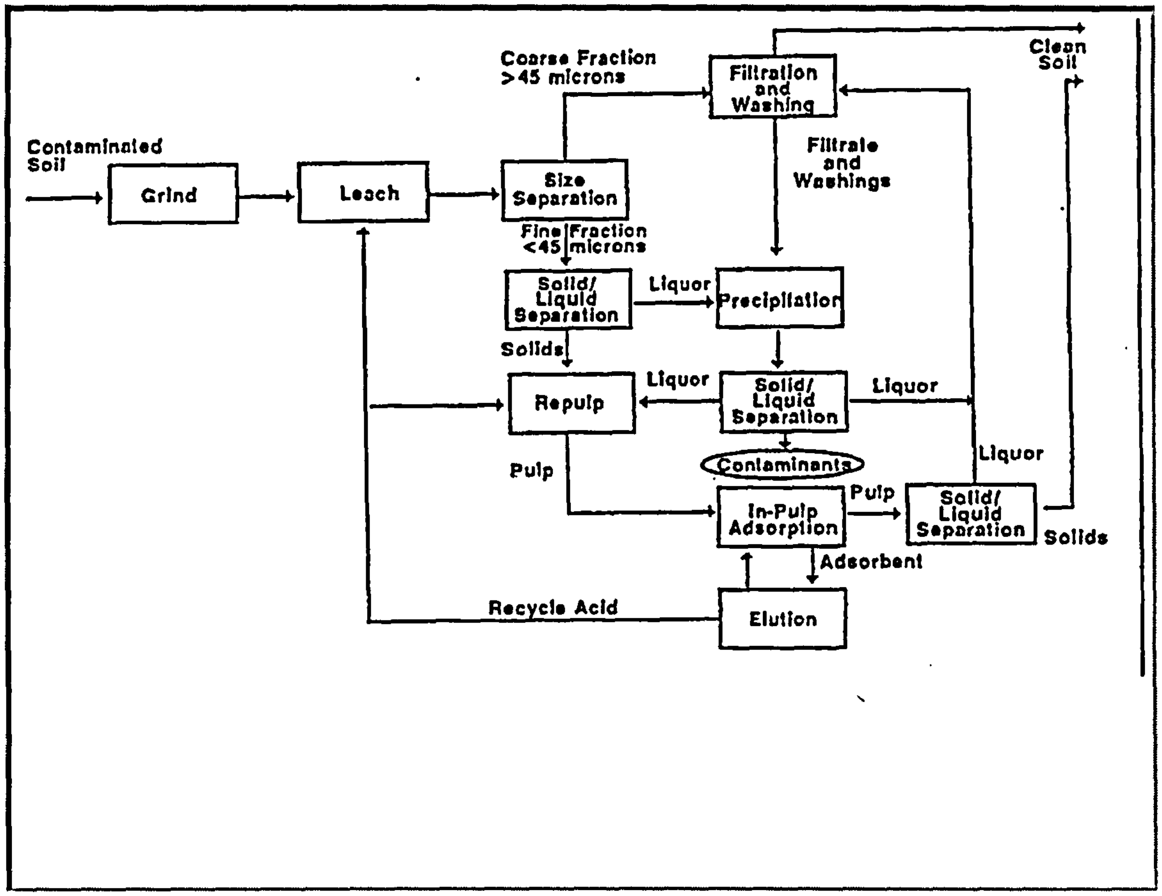
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Davy Intl In-Pulp Extraction Process





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Davy Intl In-Pulp Extraction Process

22-Dec-97

Project: Hamilton Harbour Project **Year: 94**

Location: Hamilton, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre · Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. Viscous grey slurry with a strong organic smell. The slurry was continually mixed to enable representative smaples to be taken for test work. The pulp was characterized for pulp density, size analysis, loss on ignition, acetone soluble organic material as well as metal contamination. The sam[ple was 90% finer than 90 microns making it amenable to in-pulp treatment. However, 2% was coarser than 350 microns and will require pretreatment. The sample contained a magnetic fraction assumed to be an iron alloy. The iron content was 19% suggesting a magnetic separation pretreatment step as a possibility. The LOI at 900°C was 22% with about 8% being lost at 450°C. Only approximately 2% of the sample was soluble in acetone leaving 20% as insoluble organic material which probably includes coal or coke breeze. The organic fraction will also require a processing step.

Contaminants Treated: Zinc, lead, iron and manganese levels in the sediment sample exceeded the Ontario "severe effect" guidelines while copper, chromium and nickel contaminant levels were between the "severe effect " and "limited effect" levels.

Compounds	Untreated (mg/kg)	Treated (mg/kg)	Removal
Copper	90	20	80 %
Lead	735	90	88 %
Nickel	40	30	36 %
Zinc	4798	697	87 %

Emissions/ByProducts: Possibility of gaseous emission in the leach stage if anaerobic activity has produced sulphides, arsenides, etc. Decanted water from excavated sediment may be contaminated and may require treatment.

Description: It was determined during sample characterization that zinc, lead, iron and manganese levels exceeded the Ontario "severe effect" guidelines. Copper, chromium and nickel contaminant levels were between the "severe effect" and "limited effect" levels. Initially a series of leaching screening tests were carried out to determine the most appropriate leaching reagent. This was followed by adsorption testwork, precipitation testwork and development of flowsheets.

RESULTS

The test programme proposed by Davy International was successfully carried out and showed that all contaminants apart from iron could be leached to below the Ontario "severe effect" guidelines. The iron was shown to be magnetic and it may be possible to remove this by magnetic separation. The high concentrations of calcium and iron ions in solution inhibited adsorption and further work will be required to develop the adsorption stage.

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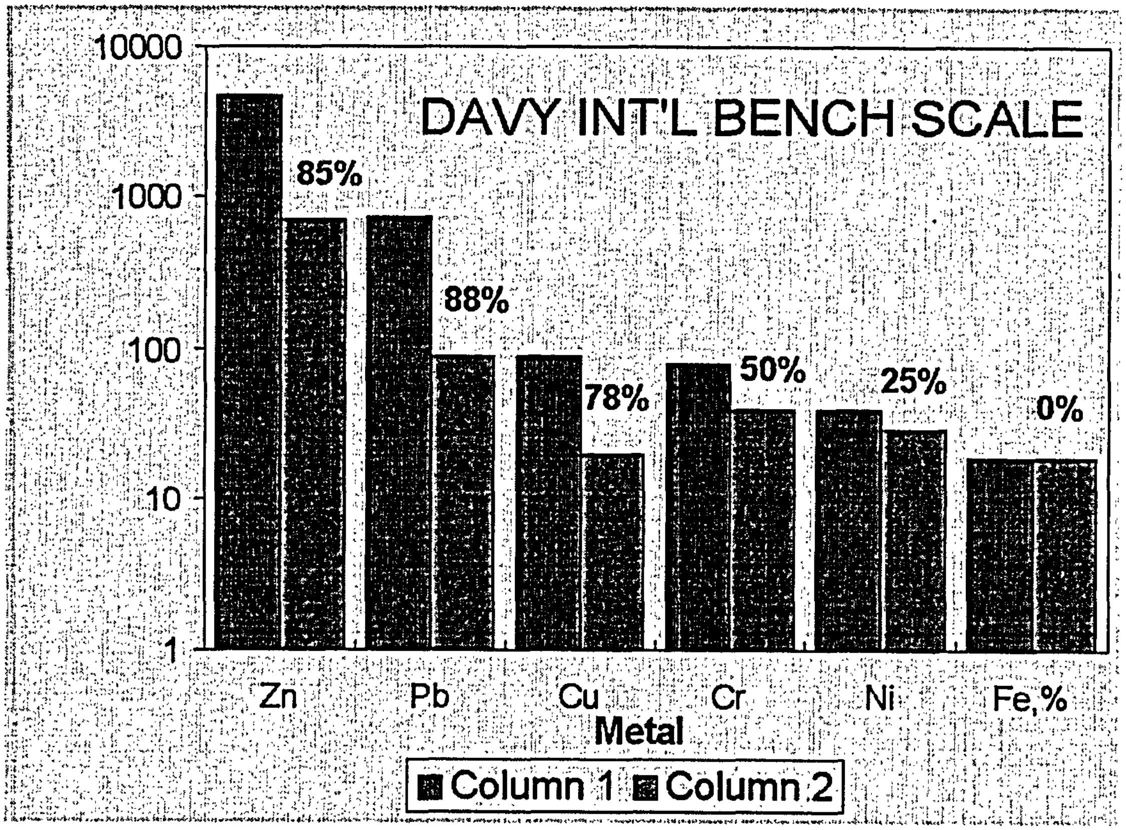

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Davy Torbed

22-Dec-97

Technology Type: Thermal

TechID: 202

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** England **Portable:** ☒

Description:

The Torbed is a novel concept in heat and mass transfer. The Torbed's advantages stem from its ability to direct high velocity gas streams onto material held in a shallow closely packed bed. The resultant high heat and mass transfer rates have enabled the design of a compact process/incineration unit which has been proven in a number of commercial applications. The Torbed process has the following benefits over other fluidized bed incinerator units:

- faster processing times

- ability to handle a wide range of particulates. The process is not dependent on particle shape

- the smaller units are skid mounted, easy to install and could be transferable

- a high degree of control permits precise processing of materials.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.75

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Davy Energy & Environmental
Ashmore House
Stockton-on-Tees, Cleveland
England TS18 3RE
Notes

Contact: Morris, J.
Phone: 0642 602221 Ext:
Fax: 0642 341001
Email:

Vendors:

Davy Canada, Inc.
Suite 1800, 480 University Avenue
Toronto, Ontario
Canada M5G 1V2
Notes

Contact: Thom, Ian
Phone: (416) 340-1145 Ext:
Fax: (416) 343-9300
Email:

Davy McKee Corporation
2440 Camino Raman, Suite 100
San Raman, CA
USA 94583-
Notes

Contact: Donnelly, J.
Phone: (510) 866-1166 Ext:
Fax: (510) 866-6520
Email:

Literature References:

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Dehydro-Tech Corp., Carver-Greenfield Process

22-Dec-97

TechID: 41

Technology Type: Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

This process separates a waste matrix into solids, water, and oil phases. A carrier oil ... oil extracts oil-soluble contaminants, primarily hydrocarbons, but also materials complexed with the ... evaporation. Once dry, centrifugation is used to separate the bulk of the oil phase from the solids. ... ed. Oil that remains with the solids is extracted through hydroextraction in which the carrier oil is ... rier oil is recovered by evaporation and distillation. Oil soluble contaminants are concentrated ... ecovery. Volatiles are stripped and recovered during either the water or carrier oil evaporation

Organic Extraction

The Carver-Greenfield Process has been commercially applied to municipal and indu

Limitations: Feeds to the process must include solids (5 to 95%), water (5 to 95%) and oil soluble contaminants (percentage level to over 75 %) to maximize its capability. While volatile organics (boiling points below 175 °C) can be processed and recovered, the technology is more appropriate for semivolatile (boiling points above 175 °C) and non-volatile organics. Note that the technology separates and concentrates feeds into solids, water and oil-soluble streams but does not destroy them. The separation reduces volume and facilitates further treatment/disposal. Pretreatment is required to reduce the particle size of the feed to 0.5 cm or less.

Efficiency Description: >99% oil soluble materials

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): **10** Breakdown Time (days): **5**

Feed Rate Average (Tonne/hr): **0.06**

Cost: Capital Cost (US$): **$1,300,000.**

Treatment Cost (US$/Tonne): **$10.00 – $300.00** Average Cost (US$/Tonne): **$155.00**

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products: treated dry solids in powder form, oil & oil soluable substances (contaminants) and water (requiring treatment)

Developers:

Dehydro-Tech Corporation
6 Great Meadow Lane
East Hanover, NJ
USA 07936-
Notes

Contact: Trowbridge, Theodore
Phone: (201) 887-2182 Ext:
Fax: (201) 887-2548
Email:

Vendors:

Dehydro-Tech Corporation
6 Great Meadow Lane
East Hanover, NJ
USA 07936-
Notes

Contact: Trowbridge, Theodore
Phone: (201) 887-2182 Ext:
Fax: (201) 887-2548
Email:

Literature References:

Author: **Sizemore, H.M., Smith, D.L.**
Title: Sludge Disposal for the City of Los Angeles - Hyperion Energy Recovery System
Journal: City of Los Angeles Date: **Jul 1980**

Author: **Holcombe, T.C., Cataldo, J., Ahmad, J.**
Title: Use of the Carver-Greenfield Process for the Cleanup of Petroleum Contaminated Wastes
Journal: NY-NJ Environmental Expo '90, Seacaucus, NJ, USA Date: **Oct 1990**

Author: **Trowbridge, T.D., Holcombe, T.C., Kollitides, E.A.**
Title: Extraction and Drying of Superfund Wastes with the Carver-Greenfield Process
Journal: Date: **Jun 1991**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Journal: 3rd Forum on Innovative Hazardous Waste Treatment Technologies — Date: Jun 1991

Author: **Trowbridge, T.D., Holcombe, T.C., Rawlinson, C.T.**
Title: The Carver-Greenfield Process for the Treatment of Oily Refinery Sludges
Journal: — Date: **Nov 1991**

Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: Carver Greenfield - Technology Evaluation Report
Journal: EPA/540/SR-92/002 — Date: **Oct 1992**

Author: **US EPA**
Title: The Carver-Greenfield Process - Applications Analysis Report
Journal: EPA/540/AR-92/002 — Date: **Oct 1992**

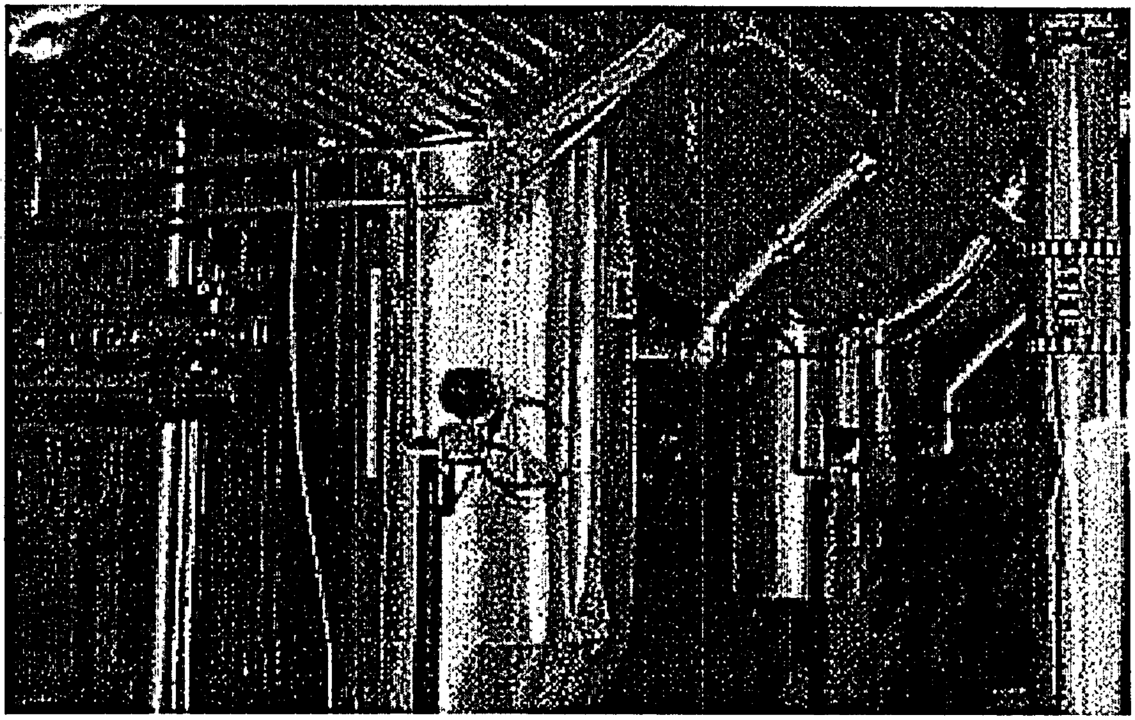
Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: Environmental Processes '93
Journal: Hydrocarbon Processing — Date: **Aug 1993**

Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: Refinery Sludge Treatment and Minimization with the Carver-Greenfield Process
Journal: I & EC Symposium-Emerging Technologies in Hazardous Waste Management V, American Chemical Society, Atlanta, GA, USA — Date: **Sep 1993**

Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: The Carver-Greenfield Process: An Alternative or Complement to Hazardous Waste Incineration
Journal: HMC/Superfund XIV Conference, Washington, DC, USA — Date: **Nov 1993**

Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: Waste Treatment Via Solvent Extraction/Dehydration with the Carver-Greenfield Process
Journal: I & EC Special Symposium, American Chemical Society, Atlanta, GA, USA — Date: **Sep 1994**

Author: **Trowbridge, T.D., Holcombe, T.C.**
Title: The Carver-Greenfield Process: Resource Recovery System for Wet, Oily Wastes
Journal: Superfund XV - Washington, DC, USA — Date: **Nov 1994**



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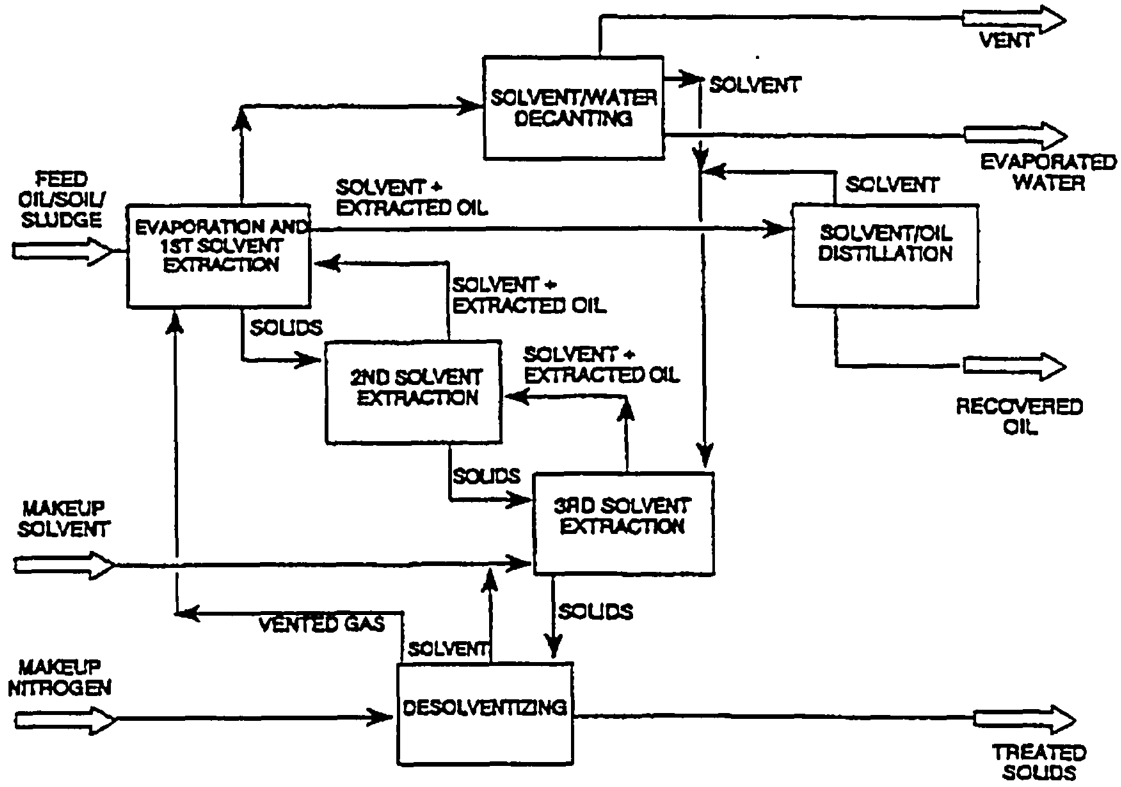

Carver-Greenfield Process Schematic Diagram

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Project: Confidential 3 **Year: 93**

Location: Confidential, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.005

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Contaminants	Untreated (ppm):	Treated(ppm):
TPH	280000	5000
Benzene	1027	2
Toluene	3630	4
Ethylbenzene	3630	0
Xylenes	9589	1
Phenols	10960	35
Cresols	1500	5
Naphthalene	19178	1
Phenanthrene	18493	13
Bis(2-ethylhexyl) Phthalate	8219	35
Anthracene	2191	10
Styrene	6849	12
2-Methylnaphthalene	38356	1
Acenaphthalene	3082	16
Di-n-octylphthalate	7534	5
Methylene Chloride	493	0
1, 1, 1 -Trichloroethane	1643	0
Trichloroethylene (TCE)	1301	0
Tetrachloroethylene	1780	0
Chlorobenzene	493	0
Hexachlorobutadiene	8219	0
Pentachlorophenol	32294	18

Emissions/ByProducts:

Description: Site type treated: Petroleum refining and reuse. Volume/Quanitity treated: 5 kg. Cost: $200/ton.

Project: Confidential 2 **Year: 93**

Location: Confidential, USA Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.005

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Contaminants	Untreated(ppm):	Treated(ppm):
TPH	199000	2000
Toluene	1389	1.2
Benzene	1389	0
Ethylbenzene	18611	0
Xylenes	10000	0
Naphthalene	97.2	0
Fluorene	83.3	1.1
Phenanthrene	144	8.4

Emissions/ByProducts:

Description: Site type treated: Petroleum refining and reuse. Volume/Quantity treated: 5 kg. Cost: $90/ton.

Project: Carver-Greenfield SITE Demonstration **Year: 91**

Location: Edison, NJ, USA Full Scale Demo

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Client/Funding Agency	Contact	Phone
US EPA - ORD	Laurel Stanley	(513) 569-7863

Not Audited

Feed Rate (Tonne/hr): 0.15 Amount Treated (Tonne): 0.3

Treatment Cost (US$):

Setup Time (days): 10 Breakdown Time (days): 5

Media Treated: Spent Drilling Fluid

Contaminants Treated:

Contaminants	Untreated (ug/g):	Treated:	Leach. T. Meth.
Toluene	0.6 (ug/g)		TCLP
Indigenuos Oil	17 %		TCLP
Phenanthrene	16 (ug/g)	1.6 (ug/g)	TCLP

Emissions/ByProducts:

Description: The C-G Process Demonstration was conducted as a part of the SITE Program at the Risk Reduction Engineering Laboratory's Releases Control Branch facility in Edison, New Jersey, using drilling mud waste from the PAB Oil Superfund Site in Abbeville, LA. During the demonstration, the C-G Process pilot plant experienced no major operational problems. During startup and shakedown, the system exhibited minor, repairable problems.

Project: PAB Oil & Chemical Service, Inc. **Year: 91**

Location: Abbeville, LA, USA Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA/RREL	Laurel Staley	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.29

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Contaminants	Untreated (ppm):	Treated (ppm):
TPH	89000	1000
Phenols	100	0.7
Phenanthrene	8.1	1.7
2-Methylnaphthalene	26	2.3
TPH (on solids)	89000	8400

Emissions/ByProducts:

Description: Waste oily drilling mud. Cost: $100 - $200/ton.

Project: AMTRAK Railroad Property **Year: 90**

Location: Sunnyside, New York, USA Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.0045

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Contaminants	Untreated (ppm):	Treated (ppm):
PCB's	0.2	0.0001

Emissions/ByProducts:

Description: Treatability study for petroleum contaminated soil with PCB's. Cost $200/ton.

Project: Confidential 1 **Year: 90**

Location: Confidential, USA Bench Scale

Client/Funding Agency	Contact	Phone
Coastal Remediation Company	Kevin Skiles	

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Dehydro-Tech Corp., Carver-Greenfield Process

22-Dec-97

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.0045

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Contaminants	Untreated (ppm):	Treated (ppm):
TPH	10000	400
BTEX	21	0.3

Emissions/ByProducts:

Description: Treatability study for solvent/hydrocarbon-contaminated soil. Cost: $150/ton.

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Denver Process Technologies Inc., DPT Chemical Stabilization Process *22-Dec-97*

TechID: 321

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA

Stabilization/Fixation

…ible: ☒

Description:

The Denver Pro Tech stabilization technology is a proprietary three-step contaminant immo… …able chemical compounds when mixed with hazardous waste products. The volume increase foun… …ly 10 to 15% for wastes without water removal. With water present, the final treated volume will n…

Description of Chemical Reactions Involved in the Formulations of Insoluble Chemical Comp…

Phase I: The formulation of insoluble compounds in the step one reaction is based upon Denv… …ears of experience in the design of advanced metallurgical and industrial waste water treatment processes for the mining and petr…mical industries. The reactions are very effective in immobilizing toxic heavy metals.

A compliment of liquid treatment reagents (referred to as Liquid Activators) were developed which form a reaction with specific heavy metal contaminants. The appropriate liquid activator reagents are selected after a review of specific waste data and preliminary treatability testing. The liquid activators react with heavy metal contaminants to form highly insoluble heavy metal compounds. This reaction prevents the heavy metals from interfering with subsequent hydration reactions. The liquid activator functions to form compounds much more insoluble than heavy metal hydroxides or oxides.

The Phase 1 reaction process forms an extremely stable and insoluble compound that can readily be solidified into a nonleachable monolith.

Phase 2: Phase 2 of the treatment process further reduces the metal leachability within the waste. The hydration reaction involved with the treatment process produces an end product primarily of calcium aluminum silicates. These compounds are extremely stable materials which do not break down in natural or landfill environments.

The hydration reaction involves the previous formed insoluble heavy metal compound from Phase 1 along with a dry powdered reagent. The initial hydration reaction is complete in 24 hours and results in a solid matrix. The TCLP leachate from the treated waste will now comply with regulatory requirements.

Phase 3: Microencapsulation of the above reaction products into a high strength monolith. This third phase is parallel to a pozzolanic reaction in that it is a slow on-going reaction which forms complex metal silicate and aluminate compounds. These silicate comounds are similar to naturally occuring silicate compounds (rock forming silicates) which are extremely stable compounds.

The stability of compounds formed by pozzolanic reactions is demonstrated by the stability of ancient pozzolanic cement structures dating back thousands of years.

Phase 3 is a long-term pozzolanic reaction to reagents already introduced in the treated hazardous waste. The slow improvement in leachability and strength increases in time. The step three reaction improves leachability, monolith strength, and compression strength; and lowers permeability. This combination of factors produces redundant safeguards against environmental releases of contaminants.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals EPA/BADT

Setup/Feed: Setup Time (days): 7 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 100

Cost: Capital Cost (US$): $100,000.00

Treatment Cost (US$/Tonne): $30.00 – $60.00 Average Cost (US$/Tonne): $45.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

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Denver Process Technologies Inc., DPT Chemical Stabilization Process

22-Dec-97

Denver Process Technologies Inc.
P.O.B. 620039
Littleton, CO
USA 80162-
Notes

Contact: McCarthy, Don
Phone: (303) 794-0754 Ext:
Fax: (303) 795-7539
Email:

Vendors:

Denver Process Technologies Inc.
P.O.B. 620039
Littleton, CO
USA 80162-
Notes

Contact: McCarthy, Don
Phone: (303) 794-0754 Ext:
Fax: (303) 795-7539
Email:

Literature References:

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Denver Process Technologies Inc., DPT Chemical Stabilization Process

22-Dec-97

Project: Brower Gold — **Year: 94**

Location: Jefferson, South Carolina, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 1 — Amount Treated (Tonne): 100

Treatment Cost (US$): $16,000.00

Setup Time (days): 2 — Breakdown Time (days): 1

Media Treated: Waste water treatment sludge

Contaminants Treated:

	Untreated:	Treated:	% Removal
Selenium (Se)	5000 ug/l	500 ug/l	90

Emissions/ByProducts: None

Description: Cleanup Goals: Selenium in sludge to less than 1000 ug/l. Project approved by state DEQ.

Project: Refinery Sludge Pond Closure — **Year:**

Location: ,,USA — Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): — Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): — Breakdown Time (days):

Media Treated:

Contaminants Treated:

	Untreated:	Treated:	% Removal
Lead	2000 mg/l	0.150 mg/l	

Emissions/ByProducts:

Description: Major Great Lakes Iron Ore Mine required pretreatment for heavy metal removal from mine site runoff water prior to off-site (NPDES permited) discharge into State waters. Treatment Protocol: Formulated proprietary reagents to treat heavy metal contaminated refinery sludges. Supplied reagent technology and field technical service for insitu stabilization and closure of two sludge impoundments. Designed and supplied water treatment system to handle surface runoff for direct discharge to state waters. Project was developed from bench-scale treatability through field pilot confirmation. Operating cost (Chemicals only): $25.00/Treated Ion.

Project: Solid Assay Lab Hazardous Wastes — **Year:**

Location: , Nevada, USA — Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): — Amount Treated (Tonne):

Treatment Cost (US$): $100,000.00

Setup Time (days): — Breakdown Time (days):

Media Treated:

Contaminants Treated:

	Untreated:	Treated:	% Removal
Lead	20,000 mg/l	5.0 mg/l	

Emissions/ByProducts:

Description: Major Nevada Gold Mine pretreatment of metal contaminated solid wastes from mine assay laboratory for permitted non-hazardous on-site disposal. Treatment Protocol: Project was developed from bench-scale treatability through field pilot confirmation. Full-scale design will incorporate primary crushing, slurry thickening, and final slurry mixing. Dry reagents are metered into the mixing unit feed via a speed controlled auger feeder on the bottom of the reagent storage bin. Liquid reagents are fed with metering pumps. The "charged" feed enters the mixing unit where the reagents are thoroughly blended into the lead waste. Mixer discharge is transferred to a transportable container for curing and TCLP confirmation testing. Certified non-hazardous solid waste is transported and disposed on-site. Operating cost (Chemicals Only): $150.00/Treated Ion. Process Design Capacity: 20,000 lb/month.

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Derrick, Solid/Liquid Separation Technology

22-Dec-97

TechID: 60

Technology Type: Pre Treatment, Physical

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Derrick Solid/Liquid Separation Technology refers to a series of conventional unit operations configured to accomplish specific project objectives. These unit operations can include, but are not limited to, screening, hydraulic classification, chemical flocculation, oil/water separation, and centrifuging. As contaminant levels generally vary according to particle size or mineralogy, solids can be separated into various fractions on the basis of size or specific gravity. In this way, significant volume reductions can be accomplished, greatly reducing the amount of material requiring further treatment. Alternative, unit operations can be assembled to dewater dredged sediments, for example, prior to other treatment technologies.

Limitations: This is a separation and dewatering technology only. Some volume reduction may be achieved.

Efficiency Description:

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Approvals were received from the Province of Ontario for the Welland project.

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 75

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $5.00 – $20.00 Average Cost (US$/Tonne): $12.50

Scope of work begins at scalping screen. Assuming total amount treated 10,000 tonnes. NOTE: Feed rate depends upon percent solids of dredged slurry.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: A variety of solid products are produced, each of which will proceed to a treatment process, recycling or disposal. Process water proceeds to treatment.

Developers:

Derrick Environmental Services Corp.
590 Duke Road
Buffalo, NY
USA 14225-
Notes

Contact: Valine, Steven B.
Phone: (716) 683-9010 Ext:
Fax: (716) 683-4991
Email:

Vendors:

Dagex Inc.
9030 Leslie St., Unit 5
Richmond Hill, Ontario
Canada L4B1G2
Notes

Contact: Griffiths, Gordon
Phone: (905) 771-8400 Ext:
Fax: (905) 771-8911
Email:

Literature References:

Author: **Wastewater Technology Centre**
Title: Acres/Derrick Pilot-Scale Demonstration
Journal: GLCF Fact Sheet Number 12 Date:

Author: **Acres International Ltd.**
Title: Bench-Scale Treatability Studies on Welland River Sediments
Journal: Date: Jul 1992

Author: **Wastewater Technology Centre**
Title: Acres Treatability Study - Welland River Sediment
Journal: GLCF Fact Sheet Number 6 Date: Sep 1992

Author: **Miles, Philip**
Title: Sediment and Water Quality Monitoring as Part of the Welland River Pilot Scale Sediment Removal Demonstration
Journal: Proceeding of Sediment Remediation '95 Conference Date: May 1995

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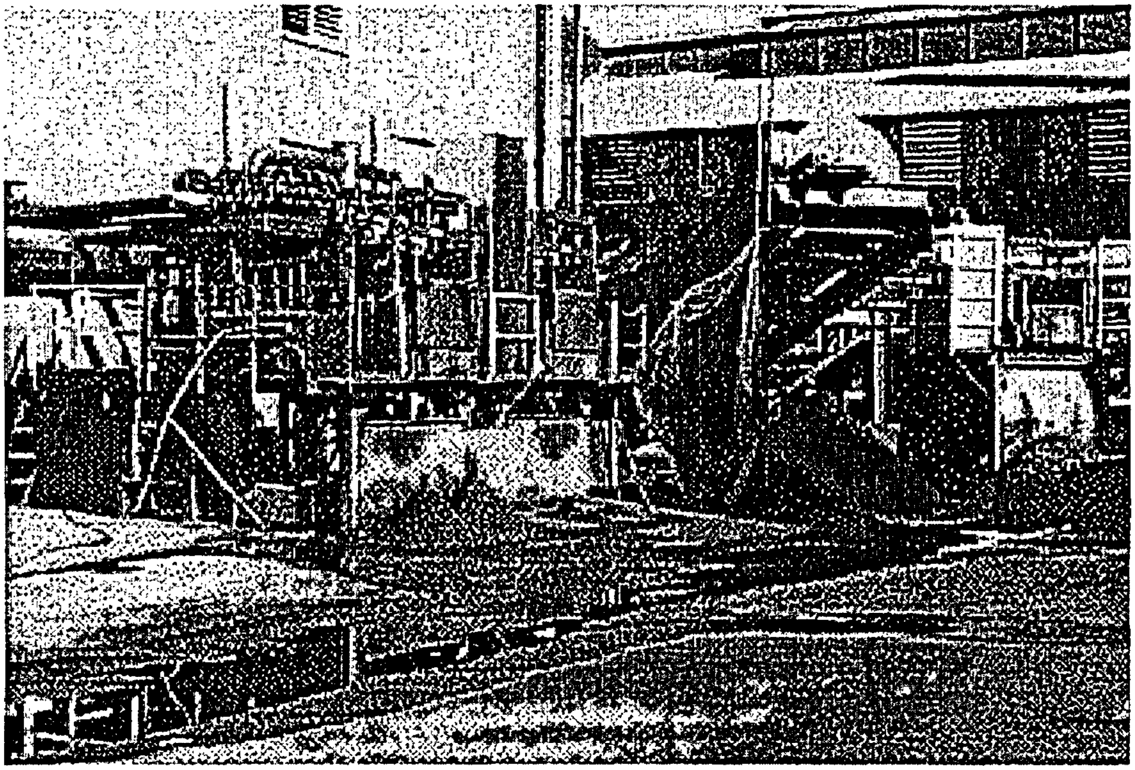
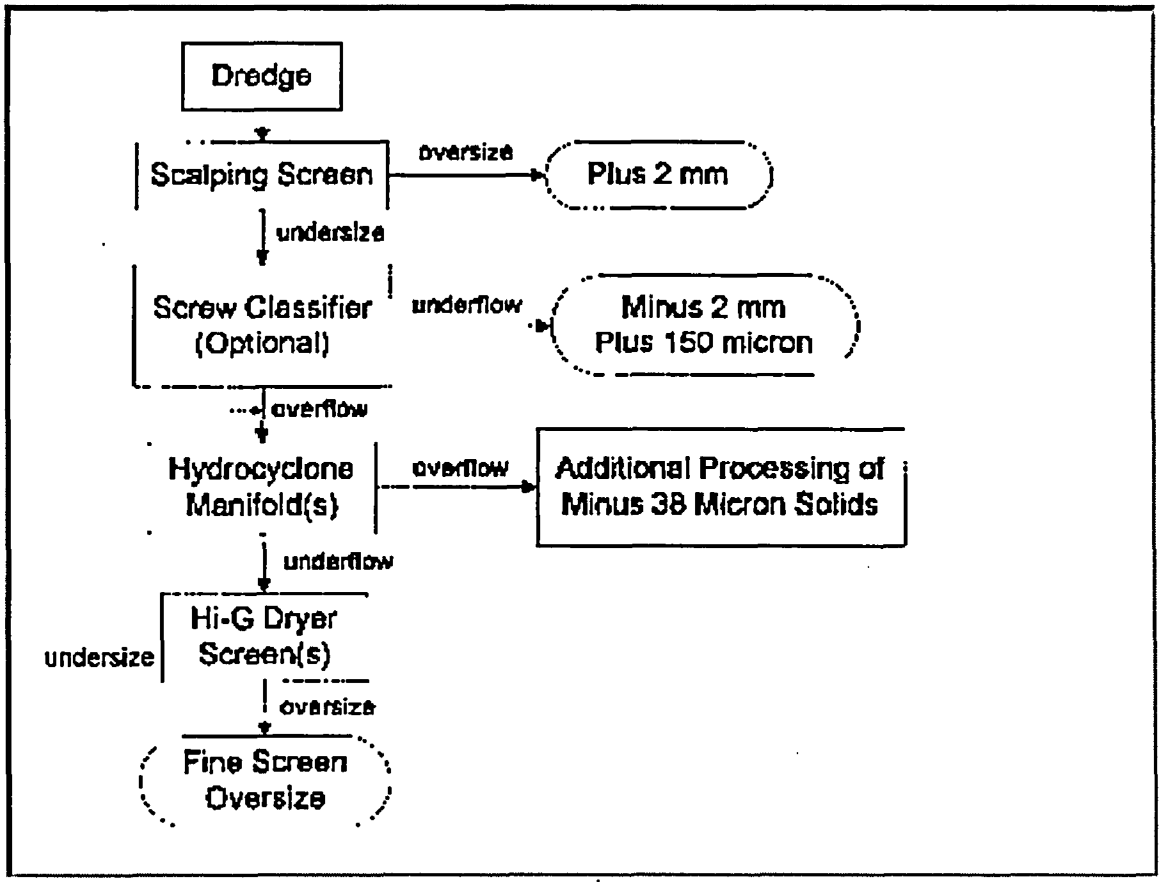
Derrick, Solid/Liquid Separation Technology





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Derrick, Solid/Liquid Separation Technology

22-Dec-97

Project: Welland River Demonstration **Year: 95**

Location: Welland, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund Atlas Specialty Steels	Ian Orchard Don Marr	(416) 739-5874 (905) 735-5661

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Welland River Project **Year: 91**

Location: Welland, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated: Oil and Grease; Heavy Metals

Emissions/ByProducts:

Description: Treatability tests were performed on samples derived from the reef material and silty clay sediment. Bench-scale tests were carried out in the following order: (1) Screening (2) Coagulation and Flocculation (3) Zone settling test (4) Flocculant settling test (5) Vacuum filtration test. Overall objective of the proposed treatment was to separate the solids and contaminants from the water in the dredged slurry so that the water could be discharged back to the river.

Project: Welland River Project **Year: 91**

Location: Welland, Ontario, Canada — Pilot Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 7613

Treatment Cost (US$): $1,318,200.00

Setup Time (days): 5 Breakdown Time (days): 2

Media Treated: Mill scale and river sediments.

Contaminants Treated: Copper, chromium, lead, nickel, manganese,iron, zinc, oil and grease

Emissions/ByProducts: Dewatered mill scale and river sediments, treated water

Description: The mass of solids removed from the dredgeate by each process was determined on-site by weighing the material in a front-end loader bucket using a mobile platform scale. Acres Analytical Ltd. determined chemical characteristics of daily composites from each unit process' solid and liquid effluents. Conventional parameters such as total suspended solids, chemical oxygen demand and nutrients were analyzed for as well as oil and grease and a suite of metals including chromium, copper, iron, lead, manganese, nickel, and zinc.

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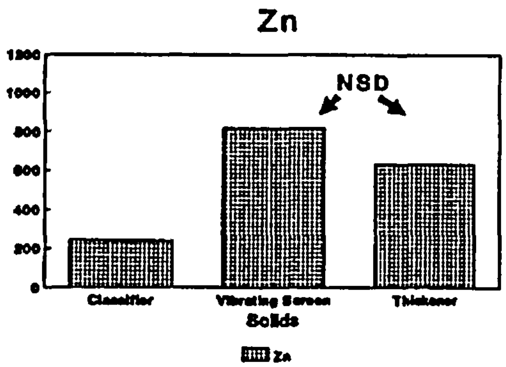

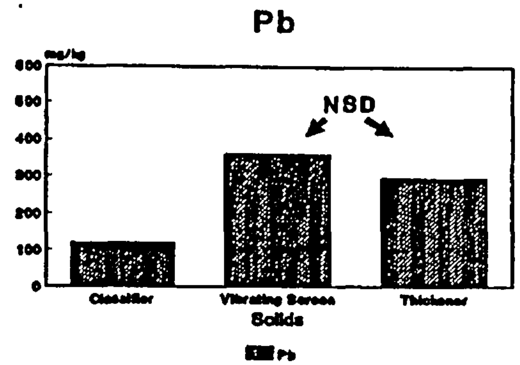

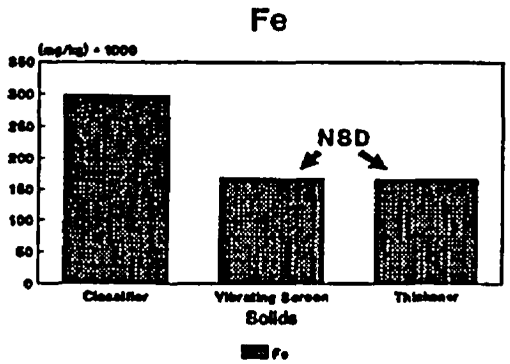

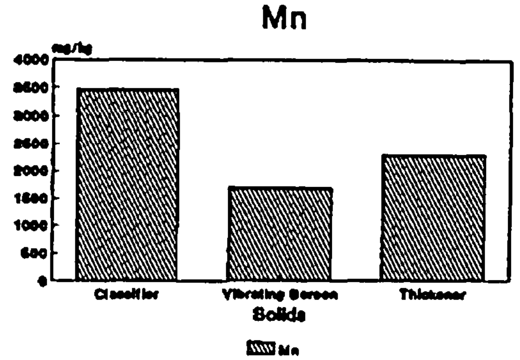

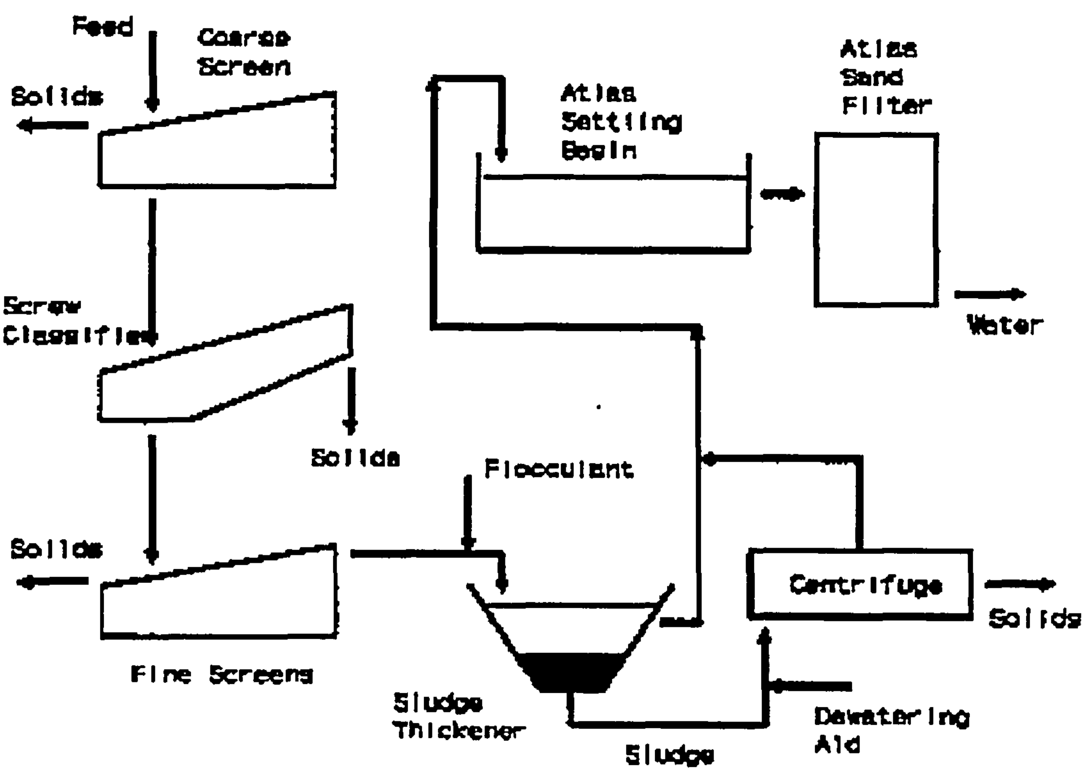

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Detox Industries Slurry Phase Biodegradation

22-Dec-97

Technology Type: Biological

echID: 187

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydro Organics, BTEX ... ted

Biological

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA ... table: ☒

Description:

Detox has isolated a range of naturally occurring non-pathogenic microorganisms which ... ial. Slurry phase biodegradation is accomplished on-site in batch reactors. Contaminant level ... target levels are reached (usually in 3 to 6 months).

The Detox technology is promoted as a PCB destruction process and has been demonstrated to reduce PCBs in soils from 2000 ppm to <4 ppm by land farming. Similarly, PCPs have been successfully degraded by landfarming.

Bioslurry degradation was applied to waste oil contaminated with PCBs. Residual levels of <1 ppm were achieved in two months from an initial average concentration of 47 ppm.

Limitations: The bioremediation process cannot destroy metals, inorganic wastes, and radioactive wastes. However, the process is effective in the presence of moderate levels of metals, inorganic wastes, or radioactive wastes.

Efficiency Description: See technology description

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals EPA Regional Approval under TSCA to diodegrade PCBs.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Carbon dioxide, methane, water and "clean" solids.

Developers:

Detox Industries, Inc.
10101 Southwest Freeway, Suite 400
Houston, TX
USA 77074-
Notes

Contact: Nagy, Robert
Phone: (713) 240-0892 Ext:
Fax: (713) 777-6032
Email:

Literature References:

Author: **Vetter, O., Balis, P.**
Title: Chromatography Software Problems for Environmental Field Analysis
Journal: Field Screening Methods for Hazardous Wastes & Toxic Chemicals, Harrington, SRI — Date: **Feb 1993**

Author: **Vetter, O., Balis, P.**
Title: Analysis of Environmental Samples for PCB's in the Field
Journal: Field Screening Methods for Hazardous Wastes & Toxic Industries — Date: **Feb 1993**

Author: **Vetter, O., Ding, Y., Balis, P.**
Title: Modeling of Subsurface PCB Transport and Fate
Journal: PCB Forum — Date: **Mar 1993**

Author: **Vetter, O., Vetter, S., Dardas, T.**
Title: Treatability Test for In-Situ Remediations
Journal: PCB Forum — Date: **Mar 1993**

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Detox Industries Slurry Phase Biodegradation

22-Dec-97

Project: RTC, Batavia Street — **Year: 93**

Location: Orange, California, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Integrated Environmental Management Inc.	John Lane	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 17200

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: In-Situ Soil

Contaminants	Untreated:	Treated:
Oil and Grease (TPH)		1000 ug/g

Emissions/ByProducts:

Description:

Project: Texas A & M University — **Year: 84**

Location: College Station, Texas, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Texas A & M - Fire Fighting School	Mr. Albert Sterling	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 63

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants	Untreated:	Treated:
PCB's (Anoclor 1260)		1 ug/g

Emissions/ByProducts:

Description:

Project: Hearne Utility Company — **Year: 83**

Location: Hearne, Texas, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Region 6 US EPA	Jim Sales	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants	Untreated:	Treated:
PCB's	2000 ug/g	

Emissions/ByProducts:

Description:

Project: Montgomery County — **Year: 81**

Location: Conroe, Texas, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 14000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

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Detox Industries Slurry Phase Biodegradation

22-Dec-97

Media Treated: Ex-Situ Soil

Contaminants Treated:

Contaminants	Untreated:	Treated:
Pentachlorophenol	1000 ug/g	1 ug/g

Emissions/ByProducts:

Description:

Project: Kerpec Trust, Harlem Ave.

Year:

Location: Lyons, Illinois, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Wickersham and Associates, Inc.	William S. Wickersham, Jr.	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 11700

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: In-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

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Dravo Rotocel

22-Dec-97

TechID: 62

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The Dravo Rotocel is a continuous extractor for granular solids. The rotor, which is divided into sector-shaped cells, turns slowly inside a vapour-tight tank. Material is continuously fed into the cells and flooded by successive washes of solvent. Solids are drained before discharge and solvent is recovered. Although originally developed for soybeans, it is adaptable to any material which can form a bed through which the solvent can percolate by gravity. The determining design factors are the rate of extraction and draining properties of the solids to be extracted.

The rotocel is available in sizes from 4 foot diameter to 37 foot diameter. The smaller diameter rotocel is utilized for demonstration purposes as it can be "plugged into" an owner's plant.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Davy Dravo-Comstock
One Oliver Plaza
Pittsburgh, PA
USA 15222-
Notes

Contact: Zavada, R.
Phone: (412) 566-3656 Ext:
Fax: (412) 566-3070
Email:

Vendors:

Davy Canada, Inc.
Suite 1800, 480 University Avenue
Toronto, Ontario
Canada M5G 1V2
Notes

Contact: Thom, Ian
Phone: (416) 340-1145 Ext:
Fax: (416) 343-9300
Email:

Literature References:

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Drillco Foundation Co. Ltd., In-situ Remediation

22-Dec-97

TechID: 57

Technology Type: Biological, Chemical

Contaminants Treated: Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, Halogenated Organics
Sulphides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The process involves injecting appropriate remediation agents directly into soil using a large diameter drill. The drill will mix the agents into the soil ensuring a homogenous, direct application of the remediating agents.

The containment and solidification of the sediment or soil by mixing with a cementatious powder is the best application of the equipment.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):
Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):
Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Drillco Foundation Co. Ltd.
215 Traders Blvd. E., Unit 7
Mississauga, Ontario
Canada L4Z 3K5
Notes

Contact: Saunders, A.
Phone: (416) 890-2834 Ext:
Fax: (416) 890-2836
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Dufferin Solidification

22-Dec-97

Technology Type: Stabilization/Fixation

TechID: 66

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Using a low cost by-product of its cement production operations, kiln dust, Dufferin proposes to stabilize contaminants in the dredged sediment. The sediment will be dewatered if necessary.

The resultant product is proposed for landfill sites namely, Dufferin's own quarries as a supplement to the daily cover requirement.

In 1980 and 1981 Dufferin worked with Dofasco Inc. in dredging material from Hamilton Harbour and stabilizing it with flyash.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 3 Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Water, stabilized soil

Developers:

Dufferin Construction Company
505 North Service Road E.
Oakville, Ontario
Canada L6H 1A5
Notes

Contact: Ostrader, P.
Phone: (905) 761-7100 Ext:
Fax: (905) 761-7200
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

E.I.L. Environmental Services Inc., Bioremediation

29-Dec-97

TechID: 114

Technology Type: Biological

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

E.I.L. cultures its own bacteria in Calgary, Canada. They also receive technical support when needed from Environmental Remediation Inc. in California. Although bench scale testing is proposed to demonstrate E.I.L. 's capabilities, they can proceed to full scale immediately.

Limitations:

Efficiency Description: Depends on contaminants

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): **10** Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water and biomass

Developers:

Environmental Remediation Inc.
2950 Buskirk Ave., Suite 220
Walnut Creek, CA
USA 94596-
Notes

Contact:
Phone: Ext:
Fax:
Email:

Vendors:

E.I.L. Environmental Services Inc.
16041 - 132 Ave.
Edmonton, Alberta
Canada T5V1H8
Notes

Contact: Michalchuk, G.
Phone: (403) 448-0866 Ext:
Fax: (403) 482-5750
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecofix, Stabilization/Fixation

29-Dec-97

TechID: 75

Technology Type: Chemical, Stabilization/Fixation, Pre Treatment, Physical

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Technology based in the fixation and/or encapsulation of heavy metals and heavy hydrocarbons by silica moleccula using long chain silicates (cements, fumes, and other silica reagents).

Several contaminants can be addressed simultaneously. Pre-treatment may be required in that case.

Limitations: Volatiles and halogenated organics can be only encapsulated at limited concentrations (Max. 5000 to 30,000 ppm).

Efficiency Description: 95 %

Government Funding: DESRT, GASReP, SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Approved by several environmental regulatory agencies both inside and outside the USA

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 1

Feed Rate Average (Tonne/hr): 55

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $90.00

Material relatively fine (< 2 cm) and less than 40% humidity for soils and max. 40% solids for sludges.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: All products of treatment are reuseable. No free water.

Developers:

Ecofix/Solroc Group
394 Isabey, Suite 210
Saint-Laurent, Québec
Canada H4T 1V3
Notes

Contact: Bensoussan, Aime
Phone: (514) 737-6541 Ext:
Fax: (514) 342-5855
Email:

Vendors:

Ecofix/Solroc Group
394 Isabey, Suite 210
Saint-Laurent, Québec
Canada H4T 1V3
Notes

Contact: Bensoussan, Aime
Phone: (514) 737-6541 Ext:
Fax: (514) 342-5855
Email:

CFX Network
P.O.B. 23644
New Orleans, LA
USA 70183-
Notes

Contact: Silverman, Jim
Phone: (504) 737-8081 Ext:
Fax: (504) 737-8094
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecofix, Stabilization/Fixation

29-Dec-97

Project: Lachine Canal **Year: 90**

Location: Montreal, Quebec, Canada
Bench Scale

Client/Funding Agency	Contact	Phone
St. Laurent Center		

Not Audited

Feed Rate (Tonne/hr): 75 Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 5 Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

	Untreated:	Treated:	% Removal
Hydrocarbons	300,000 ppm		95
Heavy Metals	200,000 ppm		99

Clean-up Goals: Ministere de l'Environnement Francais (MEF) and Canadian Council of Ministers of the Environment (CCME) for hydrocarbons and heavy metals.

Amount treated: 170 liters

Emissions/ByProducts:

Description:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecological Systems Technology Inc., Algal Scrubber

29-Dec-97

TechID: 16

Technology Type: Biological
Advanced oxidation; Adsorption; Scrubbing

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals, BTEX
Nutrients; BOD's; COD's; TP

Media Treated: Sediment Ex-Situ, Suspended Sediments

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☒

Description:

The Algal Turf Scrubber (ATS) is a bioreactor specifically designed for the culture of a benthic algal community commonly known as algal turf. The ATS consists of a tray, a wave generator, an artificial substrate and an optional artificial light source where sunlight is not available.

An algal community is seeded by utilizing standard seeding methods as developed by the Smithsonian and ESTECH scientists. The community is cultured on the substrate - usually a polyethylene screen. Once the algal community stabilizes, contaminated waters are flushed over the algae at a depth of a few centimetres. The algae absorb nutrients (nitrate, phosphorous and trace elements) and concomitantly remove organic and inorganic contaminants from the water through active biological uptake and (bio-)sorption. Photosynthesis by the algae releases dissolved oxygen into the water and raises the pH.

The algal biomass with the stored pollutants is harvested by scraping on a regular basis. Harvesting prevents sloughing of long algae strands which regenerate rapidly from basal cells left on the screen after harvesting. Frequent harvesting maintains algal turf in its young vigorous growth stage. Depending on the contaminant concentration of the algae, it may be disposed of as a fertilizer or a hazardous waste. Alternatively, the metals concentrated within the algae may be recovered by more conventional means.

It should be noted that the algal community operates effectively when most solids in the feed slurry are removed before they reach the ATS system. Ample (visible) light and a balanced nutrient supply are required to maximize algal turf productivity.

Limitations: Needs sunlight or artificial light. Biomass must be harvested. Works with up to 10% suspended solids in in-flow.

Efficiency Description:

Government Funding:

Environmental Concerns: Biomass

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):
Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$): **$500,000.00**
Treatment Cost (US$/Tonne): **$3.00 – $5.00** Average Cost (US$/Tonne): **$4.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean water, contaminants concentrated in the algae sludge

Developers:

Ecological Systems Technology, Inc. (ESTECH)
8 Spicer Cir.
Markham, ON
Canada L3R1X9
Notes

Contact: Adey, Walter
Phone: (905) 946-1435 Ext:
Fax: (905) 513-7037
Email:

Vendors:

ESTECH
8 Spicer Cir.
Markham, ON
Canada L3R1X9
Notes

Contact: Allen, Andrew
Phone: (905) 946-1435 Ext:
Fax: (905) 513-7037
Email:

Literature References:

Author: **Adey, W., Loveland, K.**
Title: Dynamic Aquaria
Journal: Academic Press
Date: **Jan 1991**

Author: **Adey, W., Luckett, C., Jensen, K.**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecotechniek Ecogrind

29-Dec-97

Technology Type: Thermal

TechID: 76

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

The Ecogrind process takes contaminated sludge and produces useable gravel. Pre-treatment, including sand separation and dewatering, is incorporated into the process for the immediate handling of dredged sediment. Additionally, waste products of a high combustive value are added to the sludge to improve heating efficiency and to control characteristics of the Ecogrind end-product.

After pre-treatment, the waste material is formed into granules or plates. The shaped material is then sintered in an oxygen rich atmosphere at approximately 1100 deg. Celsius for at least 30 minutes. During this stage of processing, organics are vapourized and burnt, and the heavy metals are fixed in the solid residue. The residue is then ground to a gravel ready for reuse.

Heat is recycled, and all other by-products are purified before release to the environment.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$250.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Purified sand, water and offgas, Ecogrind-vitrified contaminants and solids

Developers:

Ecotechniek bv
Beneluxlaan 9, P.O.Box 84
Utrecht, RK
The Netherlands 3503 -
Notes

Contact: Bouman, J.
Phone: 31 30 957922 Ext:
Fax: 31 30 940929
Email:

Vendors:

Esdex Recycling Corporation
P.O.Box 250
Cookstown, Ontario
Canada L0L 1L0
Notes

Contact: Kromhout, F.
Phone: (705) 458-9805 Ext:
Fax: (705) 458-1272
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecotechniek Extraction

29-Dec-97

TechID: 78

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

A project was successfully carried out in which beach sand was cleansed of crude oil by means of a scrubbing/extraction/ separation technique. Various extraction techniques are available.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Ecotechniek bv
Beneluxlaan 9, P.O.Box 84
Utrecht, RK
The Netherlands 3503 -
Notes

Contact: Bouman, J.
Phone: 31 30 957922 Ext:
Fax: 31 30 940929
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecotechniek Incineration

29-Dec-97

TechID: 79

Technology Type: Thermal

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

The thermal cleaning method consists of heating the soil to evaporate contaminants, destroying the evaporated contaminants, cleaning the resulting flue gases, and cooling and moistening the clean soil. Designed to destroy only cyanide and evaporable hydrocarbons the process is limited though efficient in its intended application.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 7.5

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean soil and flue-gases

Developers:

Ecotechniek bv
Beneluxlaan 9, P.O.Box 84
Utrecht, RK
The Netherlands 3503 -
Notes

Contact: Bouman, J.
Phone: 31 30 957922 Ext:
Fax: 31 30 940929
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ecotechniek Volker/Esdex Pre-treatments

29-Dec-97

TechID: 212

Technology Type: Pre Treatment

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

In the development of the Ecogrind process various pre-treatment technologies were considered, including screening, hydrocyclones, separators, and mechanical and thermal dewatering devices.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Ecotechniek bv
Beneluxlaan 9, P.O.Box 84
Utrecht, RK
The Netherlands 3503 -
Notes

Contact: Bouman, J.
Phone: 31 30 957922 Ext:
Fax: 31 30 940929
Email:

Vendors:

Volker Stevin Dredging bv
71, Oostmaaslaan, P.O. Box 2695
Rotterdam, CR
The Netherlands 3000 -
Notes

Contact: Quaak, M.P.
Phone: 31 10 4244244 Ext:
Fax: 31 10 4113362
Email:

Esdex Recycling Corporation
P.O.Box 250
Cookstown, Ontario
Canada L0L 1L0
Notes

Contact: Kromhout, F.
Phone: (705) 458-9805 Ext:
Fax: (705) 458-1272
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

EER Spout Bed Incineration System

29-Dec-97

Technology Type: Incineration

TechID: 69

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☐

Description:

Funded by the US EPA Emerging SITE program and the Gas Research Institute, EER is to construct a pilot scale Spouted Bed Incineration system for soils contaminated with toxic metals and organics. The system is well suited for soil sludges with 40-50% moisture content and thus is expected to be suitable for dewatered sediment.

EER has also had contact with IT Corporation with respect to the scale-up.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): **0.1**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$50.00 – $50.00** Average Cost (US$/Tonne): **$50.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Treated exhaust, hot water, fly ash, cyclone ash, afterburner ash, hazardous or non-hazardous bed materials, bottoms

Developers:

Energy and Environmental Research Corp.
18 Mason
Irvine, CA
USA 92718-
Notes

Contact: Taylor, D.G.
Phone: (714) 859-8851 Ext:
Fax: (714) 859-3194
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Electrokinetics Rapid In-situ Bio-Electrokinetic Remediation

29-Dec-97

TechID: 158

Technology Type: Biological

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☒

Description:

This new technology, Rapid Bio-Electrokinetic Remediation of Soils (RIBEROS), is an adaption of Electrokinetics extraction technology in the U.S. patent pending stage. The technology has application for subsurface removal of hazardous organic compounds.

The electrokinetic process is used as a pump to move hazardous mixed wastes to the site surface where soluble hazardous metals are precipitated, soluble radionuclides are precipitated, and hazardous organics are directed to high rate aerobic/anaerobic biodegradation processes.

The anaerobic process is used for bio-cleavage of the halogenated organic compounds. Filtration processes remove precipitated metals and biological residues prior to returning the decontaminated groundwater to the subsurface strata. The biological residues are removed to avoid plugging of the clay pores.

The treatment objective is to return a "clean" groundwater stream to the contaminated site and groundwater circulation is continued until the site is decontaminated. The total process will be sealed to eliminate volatile and particulate emissions. Low solubility nonpolar hydrocarbon removal is enhanced using micelle surfactant technology.

Electrokinetics claims this the RIBEROS technology is cheaper and more efficient than conventional pump-and-treat systems. The higher efficiency results from faster removal of the soluble contaminants as well as extraction of exchangeable contaminants adhering to the fine-grained soil surfaces.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 60 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.02

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $100.00 – $100.00 Average Cost (US$/Tonne): $100.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: None - totally enclosed process

Developers:

Electrokinetics Inc., La Bus. & Tech Center
LSU, South Stadium Drive
Baton Rouge, LA
USA 70803-6100

Contact: Acar, Y.B.
Phone: (504) 388-3992/8638 Ext:
Fax: (504) 388-3928
Email:

Notes Additional contact: Mr. R. Marks

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Electrokinetics Soil Processing

29-Dec-97

TechID: 81

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Heavy Metals, Radionuclides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Electrokinetic soil processing is an in-situ extraction technique for the removal of heavy metals, organic and/or inorganic contaminants from soils/sediments. The technology uses electricity to affect chemical concentrations and groundwater flow. In electro-osmosis, the fluid between soil particles moves upon application of a low DC current (milliamps per square cm) through electrodes inserted into a soil mass.

Studies indicate that an acid front is generated at the anode. In time, this acid front migrates towards the cathode. Movement of the front by migration and advection, results in the adsorption of contaminants from the soil. The concurrent mobility of the ions and the pore fluid under the electrical gradients decontaminates the soil mass. This phenomena provides an advantage over other techniques for in-situ treatment of contaminated fine grained soil.

A demonstration in Toronto, Ontario, is currently being discussed with the Ontario Ministry of Transport.

Limitations:

Efficiency Description: 75%-95% removal

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 20 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.3

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $75.00 – $230.00 Average Cost (US$/Tonne): $152.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Minimal as recovery fluids/solids can be remediated in an enclosed system

Developers:

Electrokinetics Inc., La Bus. & Tech Center
LSU, South Stadium Drive
Baton Rouge, LA
USA 70803-6100
Notes Additional contact: Mr. R. Marks

Contact: Acar, Y.B.
Phone: (504) 388-3992/8638 Ext:
Fax: (504) 388-3928
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Eli Eco Logic Process

29-Dec-97

TechID: 77

Technology Type: Thermal, Chemical

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Explosives, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The ECO LOGIC Process uses patented gas-phase chemical reduction reactions to convert highly hazardous organic contaminants into reusable, recyclable, and safely disposable products. This is not an incineration technology and as such there is no risk of dioxin or furan formation. The destruction process is closed-loop which ensures that there are no uncontrolled emissions to the environment. The ECO LOGIC Process can safely treat any combination of organic contaminants, in any medium, and at any concentration. Proven destruction and removal efficiciencies of 99.9999 percent ensure that there are no hazardous organic residuals following treatment.

Limitations: Only treats organic component of the waste stream.

Efficiency Description: Up to 99.9999% for PCB's,dioxins,PAHs

Government Funding: Great Lakes Cleanup Fund, DESRT, SITE, Superfund, ETP

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Received site specific approvals for projects in Hamilton, Bay City and St. Catherines.

Setup/Feed: Setup Time (days): 15 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 8

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $350.00 – $500.00 Average Cost (US$/Tonne): $425.00

Usually quoted on an individual basis. Rate Average: 100 - 250 tonne/day.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Gases : H2, H20, methane,ethene,CO,CO2; Clean solids

Developers:

Eli Eco Logic International Inc.
143 Dennis St.
Rockwood, Ontario
Canada N0B2K0
Notes

Contact: Hassenbach, Martin
Phone: (519) 856-9591 Ext:
Fax: (519) 856-9235
Email:

Eli Eco Logic International Inc.
143 Dennis Street
Rockwood, Ontario
Canada N0B 2K0
Notes

Contact: Nash, Jim
Phone: (519) 856-9591 Ext:
Fax: (519) 856-9235
Email:

Vendors:

Eli Eco Logic International Inc.
143 Dennis St.
Rockwood, Ontario
Canada N0B2K0
Notes

Contact: Hassenbach, Martin
Phone: (519) 856-9591 Ext:
Fax: (519) 856-9235
Email:

Eli Eco Logic International Inc.
143 Dennis Street
Rockwood, Ontario
Canada N0B 2K0
Notes

Contact: Nash, Jim
Phone: (519) 856-9591 Ext:
Fax: (519) 856-9235
Email:

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Eli Eco Logic Process

29-Dec-97

Eli Eco Logic International Inc.
2395 Huron Parkway
Ann Arbor, MI
USA 48104-

Contact: Swain, W.
Phone: (313) 973-2780 Ext:
Fax:
Email:

Notes

Literature References:

Author: **Wastewater Technology Centre**
Title: Ecologic Waste Destructor Laboratory Scale Demonstration
Journal: GLCF Fact Sheet Number 2
Date:

Author: **Eco Logic**
Title: Final Report: Lab-Scale Demonstration of Contaminated Harbour Sediment Treatment Process
Journal: Prepared for Great Lakes Cleanup Fund
Date: **Feb 1991**

Author: **Eco Logic**
Title: Final Report: Pilot-Scale Demonstration of Contaminated Harbour Sediment Treatment Process
Journal: Prepared for Great Lakes Cleanup Fund
Date: **Mar 1992**

Author: **Eco Logic**
Title: Waste Treatability Study of Northern Wood Preservers Soil and Thunder Bay Harbour Sediment
Journal: Report prepared for Great Lakes Cleanup Fund
Date: **Mar 1992**

Author: **Eco Logic**
Title: Pilot-Scale Demonstration of Contaminated Harbour Sediment Treatment Process
Journal: Report prepared for Great Lakes Cleanup Fund
Date: **Mar 1992**

Author: **Wastewater Technology Centre**
Title: Ecologic Waste Destructor Pilot Scale Demonstration
Journal: GLCF Fact Sheet Number 5
Date: **Sep 1992**

Author: **Eco Logic**
Title: Final Report: Waste Treatability Study of Northern Wood Preservers Soil and Thunder Bay Harbour Sediment: Thunder Bay, Ontario
Journal: Prepared for Great Lakes Cleanup Fund
Date: **Aug 1994**

Author: **Eco Logic**
Title: Eco Logic International Gas-Phase Chemical Reduction Process-The Thermal Desorption Unit : Applications Analysis Report
Journal: US EPA 540/AR-94/504
Date: **Sep 1994**

Author: **Swain, Wayland**
Title: Commercialization of the Eco Logic Process: A Case Study
Journal: Proceedings of the Sediment Remediation '95 Conference
Date: **May 1995**

Author: **Hallett, Douglas J., Campbell, Kelvin R.**
Title: The ECO LOGIC Gas-Phase Chemical Reduction Process
Journal: Superfund XVI, Washington, D.C., USA
Date: **Nov 1995**

Author: **Hallett, Douglas J., Campbell, Kelvin R.**
Title: The ECO LOGIC Process, and Alternative to Incineration for Canadian PCB Owners
Journal: Industry and PCB's Forum, Toronto, Ontario, Canada
Date: **Nov 1995**

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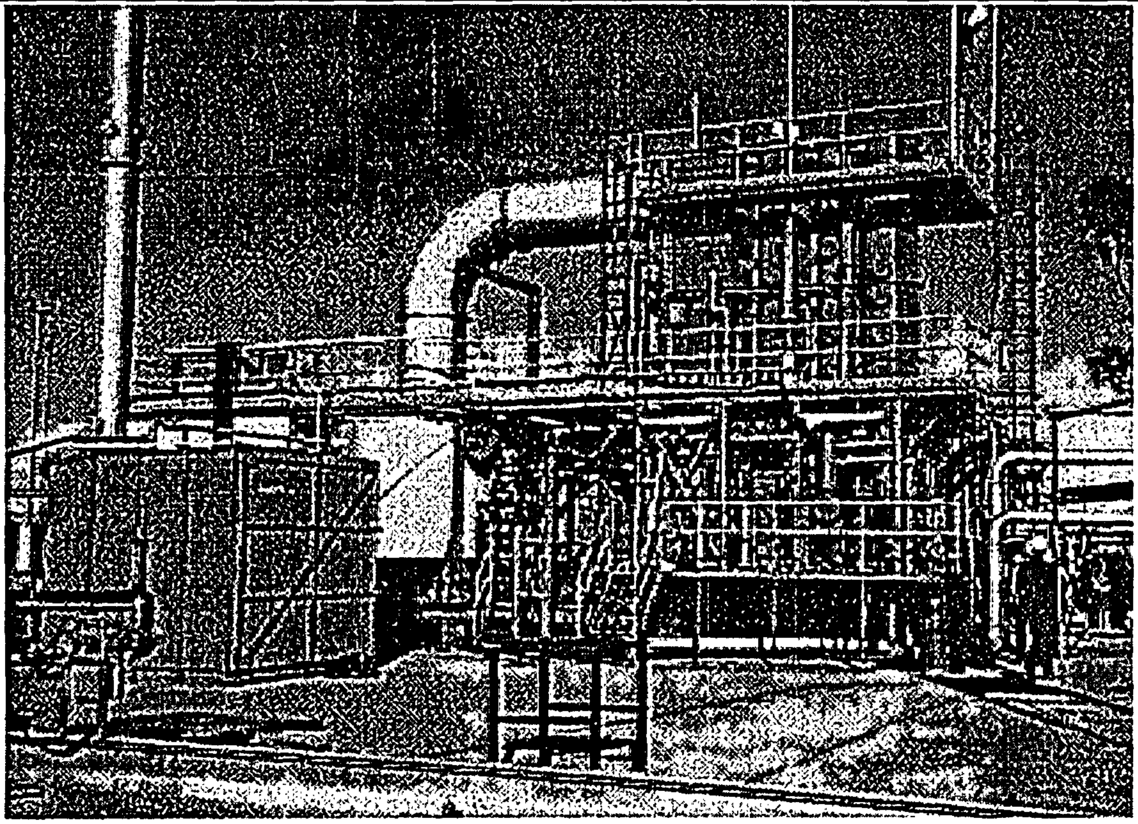
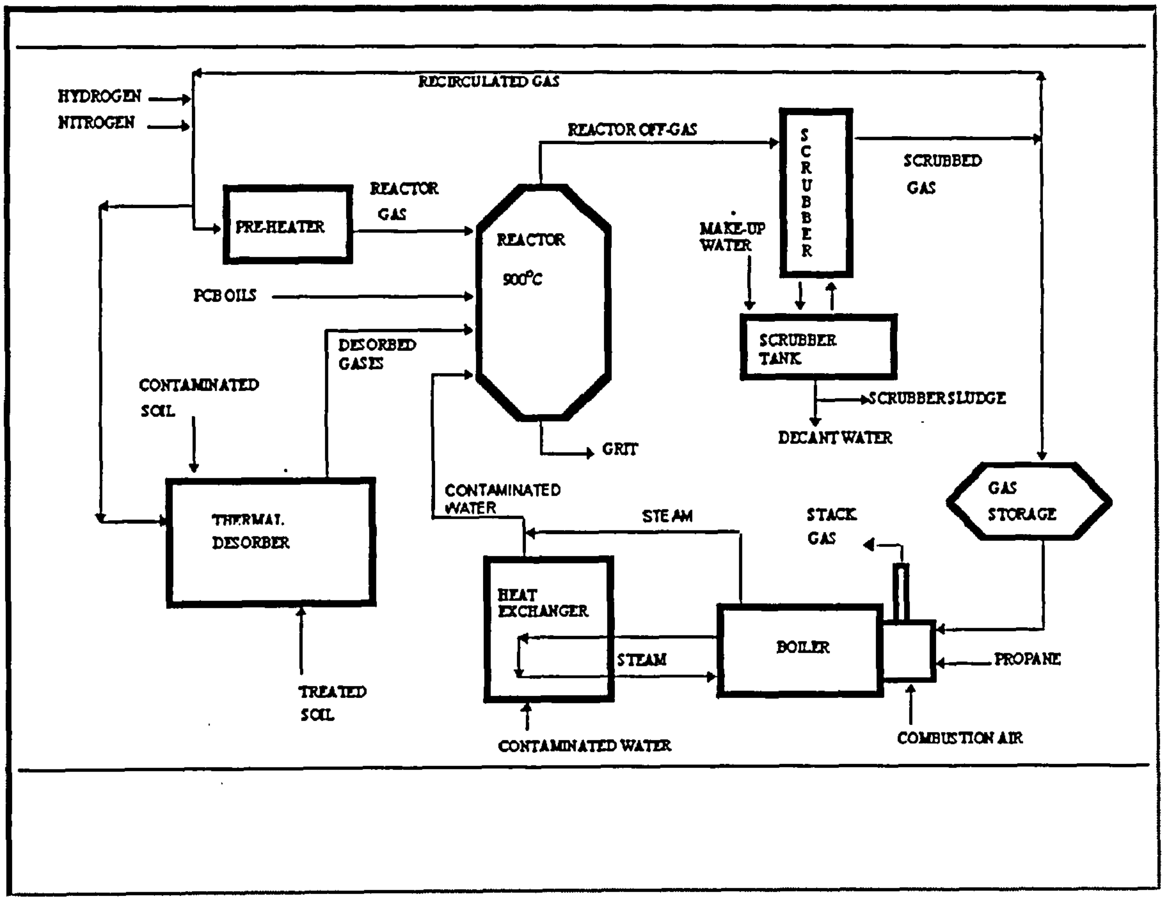
Eli Eco Logic Process





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Eli Eco Logic Process

29-Dec-97

Project: Thunder Bay Project **Year: 94**

Location: Rockwood, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273
IRAP	Ernie Davison, University of Waterloo	-

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.06

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment; Soil

Contaminants Treated:

	Untreated	Treated	% Removal
PCB's (NWP soil)	2.7 ug/g	0.0025 ug/g	99.99
PCB's (TBH sediment)	0.0077 ug/g	0.0096 ug/g	0
CP's (NWP soil)	2.41 ug/g	0.0043 ug/g	99.99
CP's (TBH sediment)	0.58 ug/g	0.0096 ug/g	99.98

Emissions/ByProducts: Hydrogen; Methane; Ethylene; Carbon Monoxide; Carbon Dioxide

Description: Soil from the Northern Wood Preservers' (NWP) site adjacent to Thunder Bay Harbour and sediment from the Thunder Bay Harbour (TBH) were tested to determine the ability of the Eco Logic Process to remove and destroy organic contaminants from PCB wastes. Both PCB's and CP's in the NWP soil and TBH sediments were well desorbed by the Thermal Desorption Unit. The project cost for soil or sediment remediation using the full-scale process unit is $400 per tonne of waste.

Project: Thunder Bay Sediment, Dioxins & Furans **Year: 94**

Location: Thunder Bay, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	Craig Wardlaw	(905) 336-4691

*** Audited *** Auditing Agency: Craig Wardlaw, David Brendon - WTC Phone: (905) 336-4665

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treatability study on Thunder Bay sediment wth respect removal of dioxins and furans. Final report pending.

Project: Bay City, Michigan **Year: 92**

Location: Bay City, Michigan, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA, Superfund, SITE	Gordon Evans	(517) 569-7684
Environment Canada	Craig Wardlaw	(905) 336-4691
Ontario Ministry of the Environment	Doug Vallery	(416) 327-8329

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PCBs, Perchloroethene, HCB, OCDD

Emissions/ByProducts:

Description: The Eco Logic demonstration project at Bay City consisted of the following three treatment phases:

1) Destruction of low level PCBs in groundwater
2) Thermal desorption of soils and destruction of PCB vapours
3) Destruction of high level PCBs (oils)

The three destruction phases each were to consist of three distinct runs, however run 3 of Phase 2 was cancelled due to time restrictions. The test runs were to be a minimum of eight hours continuous operation each. The last test run of Phase

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3 was to be a 72 hour performance evaluation (test runs did not actually last this long, see Results section). Each test was monitored by a contractor hired by the U.S. EPA. Surrogate compounds were mixed with the feed material in order to accurately determine the fate of contaminants in the system. Samples were taken by the contractor from all strategic points in order to monitor all emissions and to complete a mass balance.

The pilot scale Eco Logic demonstration unit was set up and ready to operate by September 28 1992 at the Middlegrounds Landfill. The three treatment phases were completed by December 8 1992.

RESULTS
The Bay City demonstration was successful in meeting the objectives of the project with some exceptions. The Eco Logic reactor and scrubber systems performed extremely well and met the PCB and other chemical destruction and removal criteria in all runs except one. The thermal desorber for the solids did not perform as well and did not meet the project criteria. None of the test runs lasted as long as had been planned. The planned 72 hour performance test run Iwas aborted. All of the other project objectives were met. The results of the test runs are presented in Table 1. Table 2 documents the results of other selected aspects of the demonstration based on objectives.

Project: Hamilton Harbour **Year: 91**
Location: Hamilton, Ontario, Canada Pilot Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 2.8

Treatment Cost (US$): $880,000.00

Setup Time (days): 20 Breakdown Time (days): 10

Media Treated: Hamilton Harbour is a heavily industrialized inland port. The major industry is steel production. Two large steel mills dominate the shoreline of the harbour. Iron ore, coal and other raw materials are shipped to the Harbour and various steel products are shipped out. In addition to the steel mills numerous other industries are located in Hamilton and use the port for shipping and a source of water.

For many years the discharges of all industries were not regulated or were incompletely regulated in Canada (up to about 1975). Industry discharged waste materials directly into the harbour and spills to the water were common. Stockpiles of iron ore and coal were not protected and wind and rainfall caused significant amounts of these to blow or wash into the water. Much of the discharged material settled out of the water column and built up in the sediments. Even though direct discharges to the harbour have been drastically reduced the sediments remain highly contaminated. Large areas of the harbour sustain no benthic life and the majority of the harbour has only pollution tolerant benthic species present.

The sediment in the highly contaminated areas is very oily and black. The oily material is generally referred to as "coal tar" although it is actually a mixture of coal tar, coal dust and other organic contaminants. The sediment is fine grained with a small proportion of debris (mainly iron ore nuggets). The solids content of the sediment treated ranged from 5 - 9%.

Contaminants Treated: The chemical composition of the sediment is as follows:

Polycyclic aromatic hydrocarbons (PAHs) 800 - 2000 mg/kg

Total organic carbon 10 - 30 %

Metals

Zinc	1000 - 3000 mg/kg
Lead	100 - 600 mg/kg
Iron	2 - 20 %

In laboratory bioassay tests the raw sediment kills all benthic and aquatic organisms within a few hours.
As a test, one of the desorber runs was spiked with PCBs.

Emissions/ByProducts:

Description: The pilot scale EcoLogic unit was set up and commissioned on Hamilton Harbour Commission property adjacent to one of the most contaminated parts of the harbour and tested over a period of 5 months from April to August 1991.
Results of the EcoLogic demonstration were extremely good with excellent destruction of PAHs, PCBs and other organics demonstrated. EcoLogic did not always reach the "six 9's" (99,9999%) destruction they had hoped for but given the relatively low contaminant concentrations and the nature of the sediment the results were very good. Monitoring confirmed that the process does not produce dioxins or furans. Some process problems were encountered and these have been addressed by EcoLogic since the demonstration.

Full Scale Cost Estimate: US$200 - 300/m³

For removal and destruction efficiency see accompanying figure and chart.

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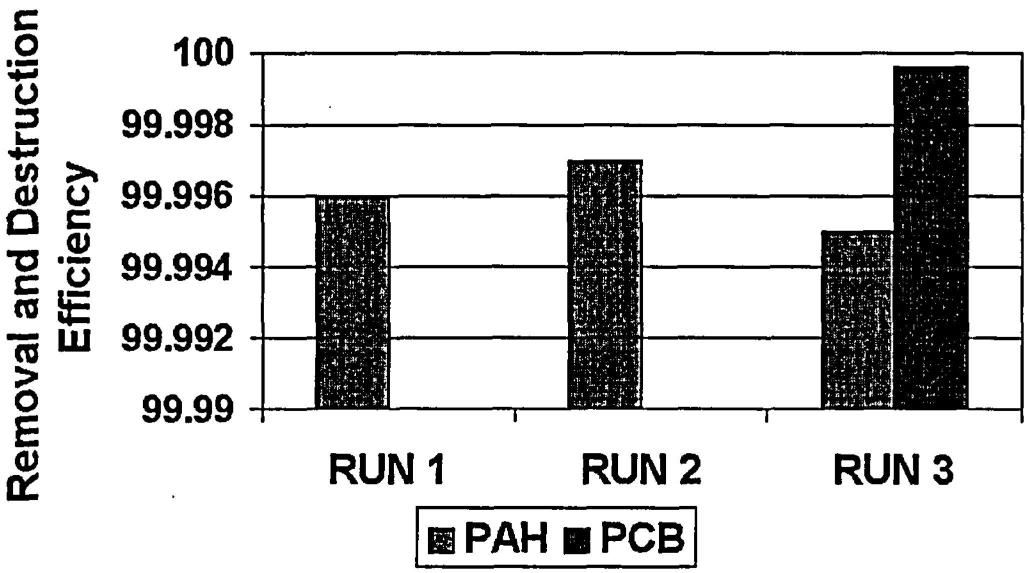

Test[1]	Mass Treated kg	Solids Conc. %	Influent Conc. of PAHs[2] mg/L	DRE[2] %
C1	200	5	6 663	99.98
C3	350	5	3 079	99.992
C5	250	6	3 517	99.996
C7	300	9	12 119	99.998
C8	300	8	11 689	99.995
C11	350	9	4 322	99.994
C12	450	6	3 267	99.989
P1	850	7	6 107	99.996
P2	900	10	7 307	99.997
P3 PAH	600	10	3 064	99.995
P3 PCB Spike	600	10	110 000	>99.9996

1 C: Characterization Test; P: Performance Test
2 The sum of the 16 US EPA priority PAHs

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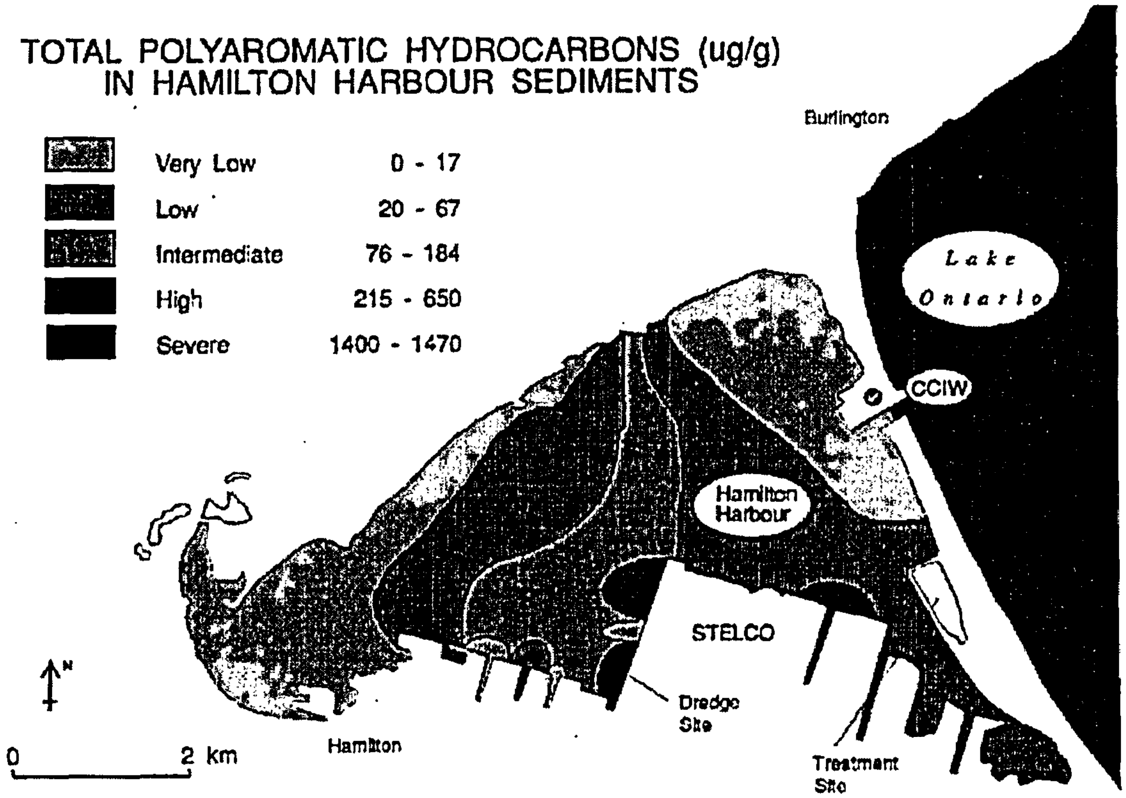

Project: Laboratory Scale Demonstration **Year: 90**

Location: Rockwood, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.05

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Hamilton Harbour and Thunder Bay Sediment

Contaminants Treated: PAHs, Trichlorobenzene, PCBs, Chlorophenols

Emissions/ByProducts:

Description: Lab scale demonstration at the Eco Logic lab in Rockwood, Ontario. EcoLogic performed a set of ten demonstration runs at laboratory scale. Four of the runs processed diluted Hamilton Harbour sediment, two processed Hamilton Harbour sediment with trichlorobenzene added, two processed Thunder Bay Harbour sediment and two processed sediment from Sheboygan Harbour Wisconsin. Each run processed approximately five litres of diluted sediment. A full analytical program was carried out and the Wastewater Technology Centre laboratory analysed five sets of duplicate samples as a check on the results.

RESULTS
See Table. Overall the results of the bench scale testing were positive. PAHs were destroyed by the reactor in some of the runs, but were actually created in two of the runs. PAH molecules were subsequently destroyed by the system in the gaseous incineration phase or removed by the scrubbers so that only extremely small amounts of PAHs were released to the atmosphere. The trichlorobenzene added to the sediment for two of the runs was almost completely destroyed by the reactor. PCBs in Sheboygan Harbour sediment were effectively destroyed by the reactor. Also, the chlorophenols in the Thunder Bay sediment were destroyed fairly well.

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Run #	Sediment	Contaminant of Concern Conc. (mg/l)		Reactor D.E. (%) **	D.R.E. (%) **
2	Hamilton	PAH	246.	85.2	99.9960
4	HH Spike TCB	TCB	365.	99.9999	100.00
5	Hamilton	PAH	272.	-150.20	99.9911
7	Thunder Bay	CPs	11.9	100.00	100.00
8	Hamilton	PAH	329.0	-1.1	99.9836
10	Thunder Bay	CPs	56.0	96.8	99.9960

** D.E. = destruction efficiency of reactor; D.R.E. = destruction removal efficiency and represents removal by all means (reactor, boiler burner, scrubber)
^ PAH = total of 16 U.S. EPA priority pollutant PAHs
^^ PCB = total of all measured PCB congeners
ND = not detected (below analytical detection limit)

Sediment	Contaminant	Feed Conc(mg/l)	WTC Lab Audit	Reactor Destruction Efficiency (%)	Destruction Removal Efficiency (%)	Residue Concentration (mg/l)
Hamilton Harbour	PAH	287	No	67.9	99.9939	ND
Hamilton Harbour	PAH	246	Yes	85.2	99.9960	ND
Hamilton Harbour	PAH	272	No	-150.2	99.9911	0.13
Hamilton Harbour	PAH	329	Yes	-1.1	99.9836	3.9
Hamilton Harbour (TCB spike)	TCB	23	Yes	99.9954	99.9990	ND
Hamilton Harbour (TCB spike)	TCB	365	No	99.9999	100.0000	0.007
Sheboygan	PB	7.4	No	99.4	99.9990	0.0023
Sheboygan	PCB	4.6	Yes	99.8	99.9941	0.43
Thunder Bay	Chlorophenols	11.9	Yes	100	100.0000	ND
Thunder Bay	Chlorophenols	56	No	96.8	99.9960	0.017

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EmTech Solidification/Stabilization Process

29-Dec-97

TechID: 82

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

This technology may be applied in-situ or ex-situ. The key component is a patented additive, chloranan, which encapsulates contaminants rendering them hydrophobic. A chloranan/water solution is mixed for a short period of time with the waste material prior to the addition of a solidifier (ie. cement). The final product is a concrete - like mass within which the contaminates are bound. The mass exhibits favourable leachate properties.

In addition to immobilization of the metals, the chemical reagants added dehalogenate chlorinated organics and oxidize a range of volatile and semi-volatile organic contaminants.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$40.00 – $100.00** Average Cost (US$/Tonne): **$70.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

EmTech Environmental Services, Inc.
303 Arthur Street
Fort Worth, TX
USA 76107-

Contact: Cardona, L.
Phone: (817) 332-5481 Ext:
Fax: (817) 338-9565
Email:

Notes

Literature References:

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Ensotech Ensol and Landtreat Process

29-Dec-97

TechID: 73

Technology Type: Chemical, Stabilization/Fixation

Contaminants Treated: Heavy Metals
Chlorinated Hydrocarbons, Cyanides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

ENSOL is a water-based product containing both sodium silicate and a proprietary chelating agent. LANDTREAT is a synthetic polysilicate with a large adsorptive capacity.

The technology utilizes ENSOL to stabilize metal contaminants in a chelated metal hydroxide silicate complex. The LANDTREAT solidifies the metal hydroxide silicate complexes producing a non-leachable final product. Additionally, the LANDTREAT adsorbs any excess ENSOL so as to provide a "buffer" against any future soluble metal occurrence.

The process is carried out in the Mobile Environmental Treatment System (METS) providing an enclosed, continuous reaction chamber.

Limitations: Can not fix soil or sediment with extremely high levels of contamination.

Efficiency Description: Over 99% reduction of solubility of metals

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns: Reduces laechability but does not remove or destroy contaminants. Long term effectiveness is unknown.

Health & Safety Plan Available: ☐

Regulatory Approvals Fully licensed in California.

Setup/Feed: Setup Time (days): 1 Breakdown Time (days): 1
Feed Rate Average (Tonne/hr): 1

Cost: Capital Cost (US$):
Treatment Cost (US$/Tonne): $40.00 – $100.00 Average Cost (US$/Tonne): $70.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: No gases are generated in the process. No effluent results from the process. Chemically inert, multi-bound metal silicate complex, non-distinguishable from the earth are formed.

Developers:

Ensotech Inc.
7949 Ajay Drive
Sun Valley, CA
USA 91352-
Notes

Contact: Sabherwal, I.H.
Phone: (818) 767-2222 Ext:
Fax: (818) 768-7510
Email:

Vendors:

Ensotech Inc.
7949 Ajay Drive
Sun Valley, CA
USA 91352-
Notes

Contact: Sabherwal, I.H.
Phone: (818) 767-2222 Ext:
Fax: (818) 768-7510
Email:

Literature References:

Author: **Ensotech Inc.**
Title: Welland River Sediments Welland, Ontario, Canada: Bench-Scale Treatability Study Report
Journal: Prepared for Great Lakes Cleanup Fund Date: Jul 1992

Author: **Wastewater Technology Centre**
Title: Ensotech Chemical Fixation Bench Scale Demonstration
Journal: GLCF Fact Sheet Number 7 Date: Sep 1992

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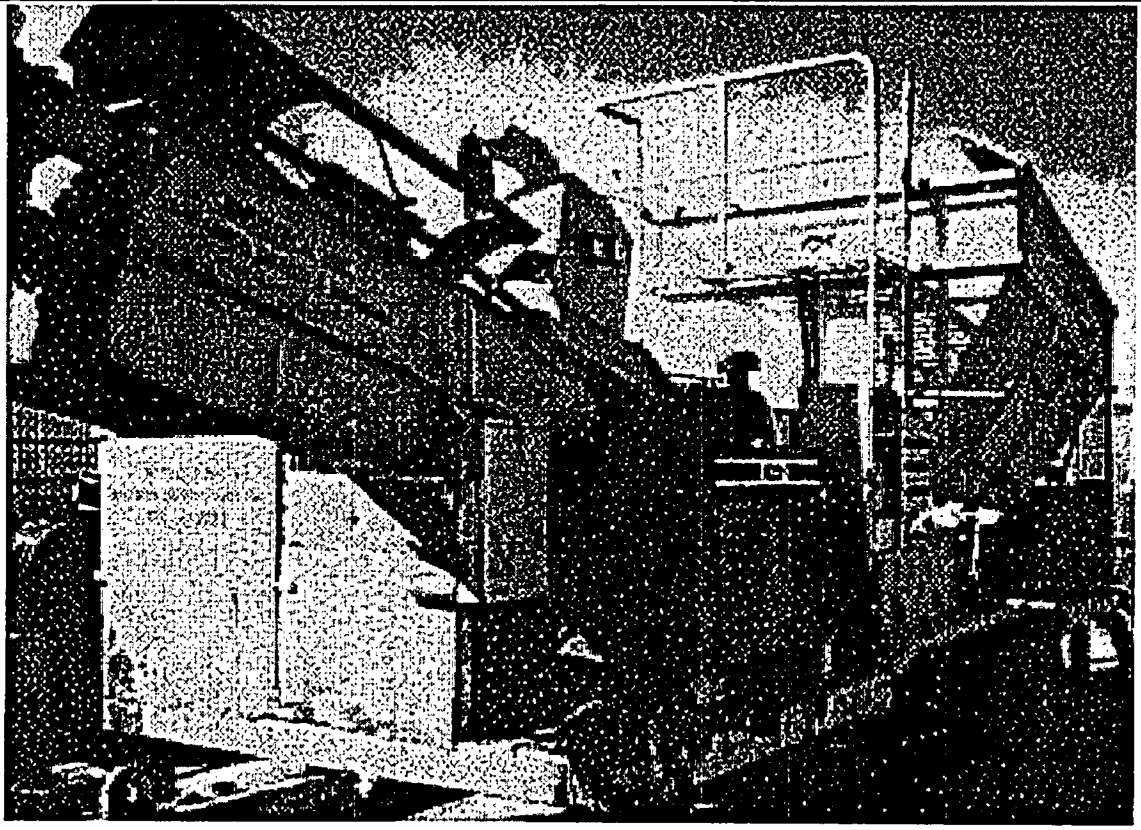

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Ensotech Ensol and Landtreat Process

29-Dec-97

Project: Welland River Project **Year: 91**

Location: Welland, Ontario, Canada

Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	Craig Wardlaw	(905) 336-4691

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. A characteristic boring log shows five types of sediment from the site: Reef Deposit, Black Silty Clay, Reddish Brown Silty Clay, Grayish Brown Silty Clay, and Reddish Brown Clay Till. The reef deposit consists of fine to coarse metallic granular material and contains an oily odor and sheen.

Contaminants Treated: Heavy Metals: Chromium, Copper, Iron, Nickel and Zinc.

Emissions/ByProducts:

Description: The purpose of this study was to assess the applicability of Ensotech's patented Chemical Fixation technology to the pilot scale and full scale treatment of heavy metal contaminated sediment.
Testing was performed on one sample of Welland River "reef material" and two samples of silty clay sediment, contaminated by exposure to the reef material. In addition, a sample of each was spiked with chromium, copper, lead and zinc.

As the Ensotech technology was designed to fix metals, leachate test were performed on the sediment to deteremine the effects of the treatments. The Ontario leachate test (MOE Reg 309) was used.
Each sediment package was teated with ENSOL, LANDTREAT and a combination of ENSOL and LANDTREAT. The response of the sediment packages to the treatments was assessed by comparing the leachate concentrations of a number of metals before and after treatment.

RESULTS
Treatment with ENSOL and the combination of ENSOL and LANDTREAT resulted in decreased leachate concentrations for the majority of metals. The most significantreduction in leachate concentration was for copper, lead, nickel and zinc. The concentrations of these metals was reduced by at lest 90%. Ensotech felt that at larger scale that economics would not justify the use of both ENSOL and LANDTREAT given the marginal improvement over ENSOL alone.
In the spiked sample only ENSOL was used and the concentrations of copper, lead, nickel and zinc were reduced by more than 99% in the leachate. Chromium, iron and manganese also responded excellently. All metals conformed to Ontario Leachate Quality Guidelines after treatment.

Cost Estimate:
Ensotech estimates cost of operation to be US$65/dry tonne of sediment, excluding pretreatment and mobilization/demolization costs.

References:
Environment Canada, Cleanup Fund Fact Sheet #7

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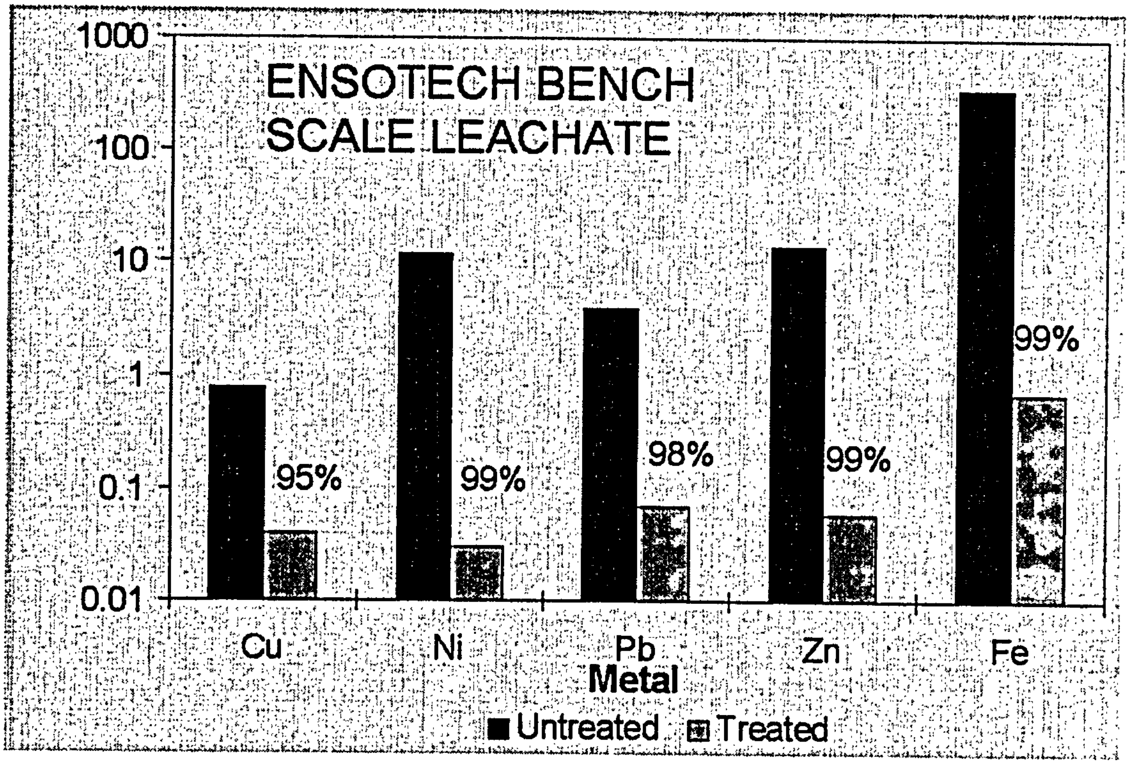

				Percent reduction in leachate concentration after treatment	
Run #	Samples	Treatment	Metals	Ensotech Analysis	WTC Analysis
1	10 gm		Cu	>84.6	72.7
	sediment		Ni	99.6	97.7
			Pb	>78.9	0
			ZN	91.9	82.3
2	10 gm		Cu	>84.6	90.9
	sediment		Ni	42	64.1
			Pb	>78.9	0
			ZN	81.7	39.9
3	10 gm		Cu	>84.6	100
	sediment		Ni	99.6	97.8
			Pb	>78.9	16.7
			ZN	96.9	89.9
4	10 gm		Cu	>99.9	100
	sediment		Ni	99.8	98
			Pb	99.95	93.2
			ZN	99.8	81.3

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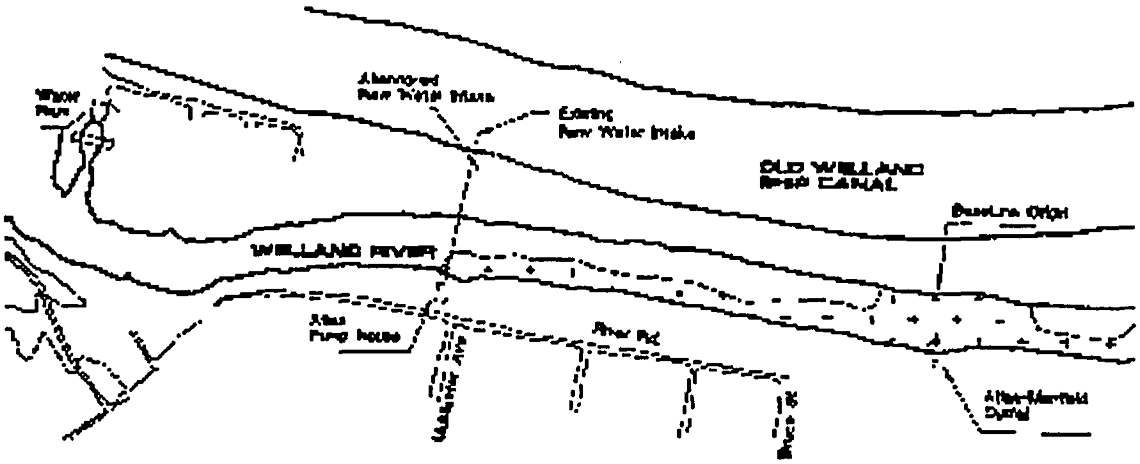

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Ensotech Landtreat and Petroxy Process

29-Dec-97

Technology Type: Chemical

TechID: 116

Contaminants Treated: PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

LANDTREAT is a synthetic polysilicate which provides a large surface area for adsorption of volatile organic compounds. PETROXY is a combination of hydrogen peroxide and other additives. The technology utilizes LANDTREAT as a reaction surface and catalyst to control spontaneous oxidation reaction between PETROXY and organic contaminants. LANDTREAT minimizes autocatalytic decomposition of hydrogen peroxide thereby increasing its utilization for oxidation of organics. It helps generate two hydroxyl radicals per molecule of hydrogen peroxide versus one nascent oxygen atom produced in absence of LANDTREAT.

As a side reaction, the active sites on LANDTREAT also react with heavy metal cations converting them to metal silicates.

The process is carried out in the Mobile Environmental Treatment System (METS) providing a completely enclosed, continuous reaction chamber.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 1

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $40.00 – $100.00 Average Cost (US$/Tonne): $70.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water, basic calcium carbonate/bicarbonate, carbon filtered air (<10ppm VOCs).

Developers:

Ensotech Inc.
7949 Ajay Drive
Sun Valley, CA
USA 91352-
Notes

Contact: Sabherwal, I.H.
Phone: (818) 767-2222 Ext:
Fax: (818) 768-7510
Email:

Vendors:

Ensotech Inc.
7949 Ajay Drive
Sun Valley, CA
USA 91352-
Notes

Contact: Sabherwal, I.H.
Phone: (818) 767-2222 Ext:
Fax: (818) 768-7510
Email:

Literature References:

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Ensotech Landtreat and Petroxy Process

29-Dec-97

Project: Long Beach Gasoline Remediation — **Year: 91**

Location: Long Beach, CA, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Bixby Land Company	Dave Anderson	(213) 494-8250

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$): $79,280.00

Setup Time (days):

Breakdown Time (days):

Media Treated: Soil

Contaminants Treated:

Contaminant	Untreated:	Treated:
TPH (Gasoline)		10 ppm

Emissions/ByProducts:

Description: The project consisted of the treatment of about 6000 m³ of soil contaminated with gasoline. The soil was excavated, treated, and backfilled at the site. The soil was treated to 10 ppm Total Petroleum Hydrocarbons (TPH) concentrations as required. The total cost of the project was $79,280 and was completed in February 1992.

Project: Anaheim Soil Remediation — **Year: 90**

Location: Anaheim, CA, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Strata Technologies, Irvine, CA, USA		

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$): $215,000.00

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated:

Contaminant	Untreated:	Treated:
TPH	2600 ppm	100 ppm
PCE	800 ppm	0.05 ppm
TCE	410 ppm	0.05 ppm

Emissions/ByProducts:

Description: About 830 m³ of Total Petroleum Hydrocarbons (TPH) and Tetrachloroethylene (TCE) contaminated soil were remediated at Anaheim, California.

Project: Oxnard Soil Remediation — **Year: 89**

Location: Oxnard, CA, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Kleinfelder Inc.		

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$): $201,000.00

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated:

Contaminant	Untreated:	Treated:
Diesel	3,000 ppm	< 100 ppm

Emissions/ByProducts:

Description: The project involved the remediation of about 1900 m³ of diesel contaminated soil using Ensotech's patented process.

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Epoc Water Exxflow and Exxpress

29-Dec-97

Technology Type: Physical, Soil Washing/Volume Reduction   TechID: 74

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial   **Country Of Origin:** USA   **Portable:** ☐

Description:

EXXFLOW and EXXPRESS are microfiltration units designed to dewater dilute (2%-5% solids) slurries.

The EXXFLOW microfiltration units consist of a woven textile support, and a membrane surface formed by the deposition of colloidal matter within the contaminated stream. By adding different filter aids to the waste, different filter characteristics may be obtained. The membrane is continually renewed by the flow of waste, and hence concentrated contaminants are swept out of the system.

The EXPRESS system is the equivalent of the above, but operated in a dead end mode. In this case, the excess solids buildup is removed by mechanical means.

Applications to dredged sediment have not been directly investigated though full-scale operations at a ceramic plant may be similar. All heavy metals are being removed and the cleansed water is being returned for plant use. Chemical dosing would most likely be required to assist in the removal of contaminants such as oil and non-volatile organics from the sediment.

The system is modular, facilitating easy set-up and additional changes. All operations are automated and minimal operator attention is required.

Since 1988 more than 45 plants have been installed worldwide with flow rates varying from 1 gpm to 2.4 million gallons per day on applications ranging from fruit juice clarification to potable water to heavy industrial wastewater.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days):   Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.0006

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): –   Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean water, toxic or non-toxic filter cake

Developers:

Epoc Water Inc.
3065 N. Sunnyside, #101
Fresno, CA
USA 93727-
Notes

Contact: Bartman, G.H.
Phone: (209) 291-8144 Ext:
Fax: (209) 291-4926
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Equipement et Machines de L'Ouest, Burger Press

29-Dec-97

Technology Type: Post Treatment, Pre Treatment

TechID: 70

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial

Country Of Origin: France

Portable: ☒

Description:

The Burger Press is a high pressure continuous dewatering press developed to produce biological sludge with 30% dry material without the addition of any chemicals or minerals such as lime. Primary dewatering occurs under 50 kg/cm2 (700 psi) of pressure from the squeezing together of two conveyer belts. Secondary drying occurs with evaporation in the machine's aeration tunnel. Water is collected in a trough underneath the press, while pressed sludge is scraped off the belts and directed to a conveyer.

Equipements et Machines de l'Ouest (EMO) manufactures a variety of dewatering equipment which is well suited for the dewatering of contaminated sediment. Normally the coarse material and sand are removed from the sediment by conventional screens and hydrocyclones. The fines are then dewatered using two EMO processes.

The Omega gravity belt thickener is used to thicken the fine slurry to about 10 % solids. The gravity belt thickener uses a filter media but no pressure and can have flowrates as high as 150 m^3 per hour.

The Omega belt filter press is a high pressure continuous flow dewatering press. It produces high solids content material without the addition of polymers or other chemicals. Two converging conveyor belts squeeze the sediment under 50 kg/cm^2 (700 PSI) of pressure. The press can have flowrates up to 100 m^3 per hour. Fines can be dewatered to 65% solids. Further drying may be accomplished in an aeration tunnel. Water is collected for treatment or disposal.

Limitations: Material must have oversized material removed before pressing.

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 6

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Water and thin solids cake, both require further treatment

Developers:

Equipement et Machines de L'Ouest
40, rue du Bignon - BP 17
Chantepie,
France 35135-
Notes Additional contact: Olivier Chagot

Contact: Saulnier, Michel
Phone: (339) 986-0203 Ext:
Fax: (339) 986-0204
Email:

Vendors:

Equipement et Machines de L'Ouest
40, rue du Bignon - BP 17
Chantepie,
France 35135-
Notes Additional contact: Olivier Chagot

Contact: Saulnier, Michel
Phone: (339) 986-0203 Ext:
Fax: (339) 986-0204
Email:

Literature References:

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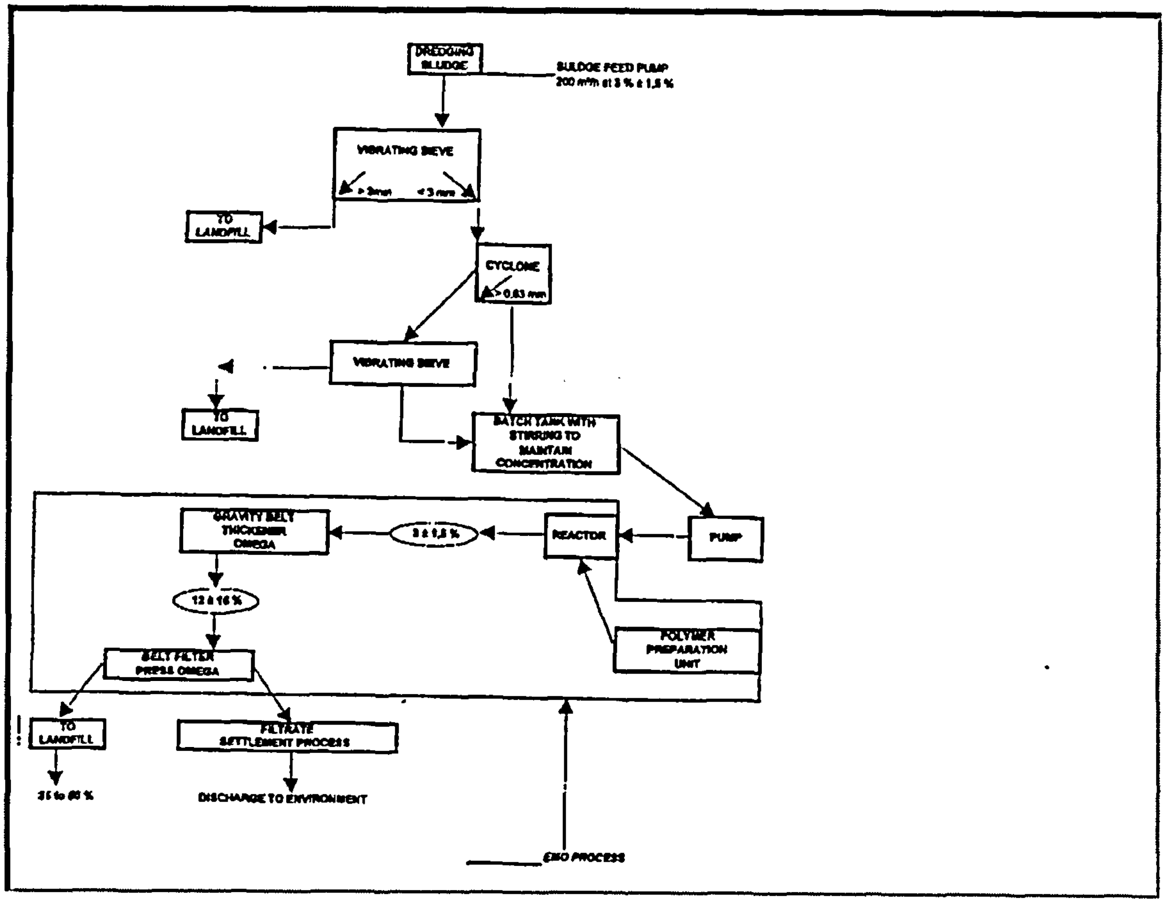
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Equipement et Machines de L'Ouest, Burger Press



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Equipement et Machines de L'Ouest, Burger Press

29-Dec-97

Project: Boskalis Project **Year: 93**

Location: ,,Holland Full Scale Demo

Client/Funding Agency	Contact	Phone
Boskalis Society		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treatment of dredged sediment with Omega 25 - Omega 250. Unit capacity: 60 - 90 m^3/hour.

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Etus Inc./ Four Seasons Environmental, TR-DETOX Heavy Metal Stabilization

29-Dec-97

TechID: 136

Technology Type: Chemical, Stabilization/Fixation, Physical

Contaminants Treated: Heavy Metals, Mercury

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

With the ever increasing regulatory pressure on metals discharge limits and sludge disposal, it is very important for operators to treat their recycled and discharge water as completely as possible. Additionally, the use of ferrous for co-precipitation now seen to generate too much sludge, which is difficult to dewater and often times requires further processing. These situations are routinely addressed and solved by ETUS. The following is a brief description of the benefits achieved, and process involved.

Benefits: 1) Transportation/Disposal Cost Reduction 2) Liability Reduction 3) Compliance to Minimization Programs
4) Reduction in Chemical Usage/Costs 5) Easier Sludge-Dewatering 6) Reduced TDS in Treated Wastewater-Integral Part of a Zero-Discharge Program 7) Weight of Sludge generated should be reduced by a minimum of 50%
8) Sludge can be disposed of as non-hazardous material

Process: 1) Elimination or reduction in the volume of iron salts and /or aluminum currently utilized for co-precipitation and coagulation 2) The use of ETUS' chelate-breaker precipitants to replace the inorganic salt 3) The use of ETUS polymers to replace the inorganic coagulant 4) The use of ETUS' Reagent Control System to monitor the waterwater status on a real-time basis and to accurately control dosing of chemical reagents.

Limitations: Will not treat other contaminants without special additives.

Efficiency Description: 99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals State of North Carolina; US EPA

Setup/Feed: Setup Time (days): 4 Breakdown Time (days): 4
Feed Rate Average (Tonne/hr): 3.5

Cost: Capital Cost (US$): $50,000.00
Treatment Cost (US$/Tonne): $70.00 – $80.00 Average Cost (US$/Tonne): $75.00
Treating 110,000 tonnes contaminated with heavy metals.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Filtercake and water.

Developers:

Etus Inc.
1511 Kastner Place
Sanford, FL
USA 32771-
Notes

Contact: Dunkel, Rich
Phone: (407) 321-7910 Ext:
Fax: (407) 321-3098
Email: dunkel@env-sol.com

Vendors:

Four Seasons Environmental
12021 Lakeland Park Blvd., Ste. 120
Baton Rouge, LA
USA
Notes

Contact: Grist, Jeff
Phone: (504) 756-2560 Ext:
Fax: (504) 756-2561
Email:

Literature References:

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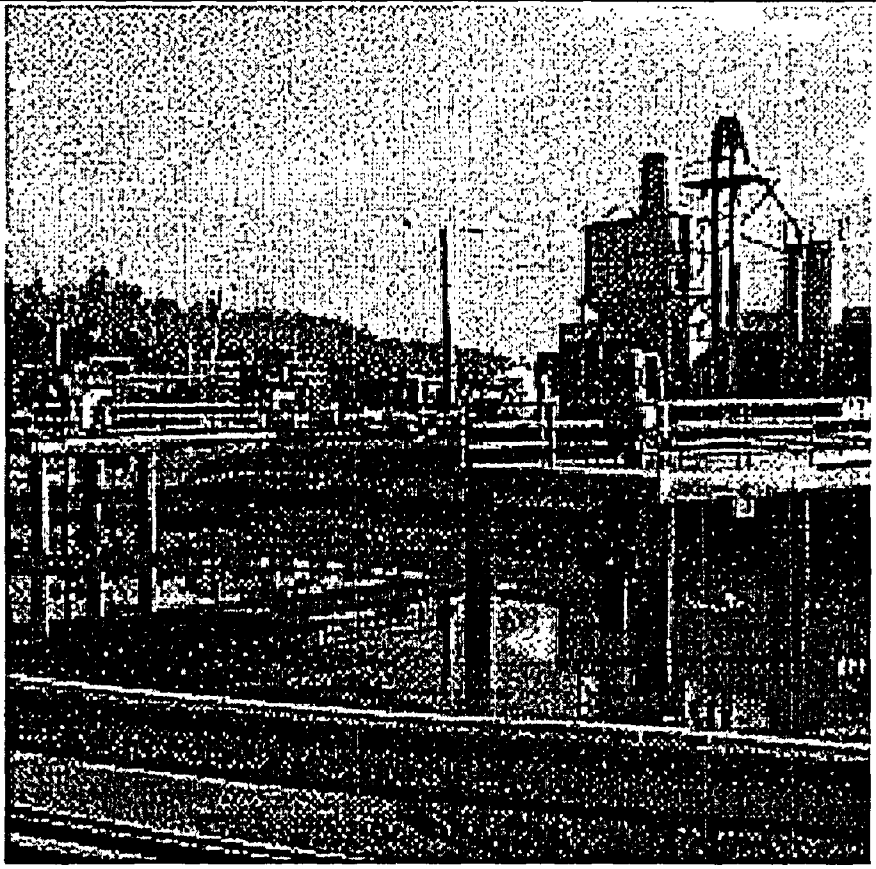

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Etus Inc./ Four Seasons Environmental, TR-DETOX Heavy Metal Stabilization

29-Dec-97

Project: Statesville Impoundment - Sediment Removal/Stabil. **Year: 95**

Location: Statesville, N. Carolina, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
City of Statesville	Joe Hudson	(704) 878-3471

Not Audited

Feed Rate (Tonne/hr): 3.5 Amount Treated (Tonne): 1600

Treatment Cost (US$):

Setup Time (days): 4 Breakdown Time (days): 4

Media Treated: Sediment

Contaminants Treated:		Untreated:	Treated:	% Removal
	Cadmium	15 ppm	< 1.0 TCLP ppm	98

Clean-up Goals: Cadmium < 1.0 ppm TCLP

Emissions/ByProducts: Filter Cake

Description: Filtercake with less than 20 % moisture content.

Project: Confidential 2 **Year: 93**

Location: , Lousiana, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 10000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:	Contaminants	Untreated:	Treated:
	Organic Lead	5 ug/g	1 ug/g

Emissions/ByProducts:

Description:

Project: Confidential 3 **Year: 92**

Location: , Indiana, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:	Contaminants	Untreated:	Treated:
	Nickel	100 ug/g	5 ug/g

Emissions/ByProducts:

Description:

Project: Confidential 1 **Year: 92**

Location: , California, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

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Media Treated: In-Situ Sediment

Contaminants Treated:	Contaminants	Untreated:	Treated:
	Arsenic	1 ug/g	0.005 ug/g

Emissions/ByProducts:

Description:

Project: Port of Baltimore **Year: 91**

Location: Baltimore, Maryland, USA

Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:	Contaminants	Untreated:	Treated:
	Chromium (Hexavalent)	100 ug/g	2 ug/g

Emissions/ByProducts:

Description:

Project: Confidential 4 **Year:**

Location: , Alabama, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:	Contaminants	Untreated:	Treated:
	Lead	10 ug/g	5 ug/g

Emissions/ByProducts:

Description:

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Extract S.A., EXTRACT System

29-Dec-97

TechID: 325

Technology Type: Soil Washing/Volume Reduction

Contaminants Treated: Petroleum Hydrocarbons, Oil & Grease, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Switzerland **Portable:** ☒

Description:

The EXTRACT sludge and soil treatment system can be adapted to a wide variety of operations or sites. There are no annoying noises or smells associated with the process, and the system does not interfere with existing operations.

The success of the EXTRACT system in reducing the volume of contaminated sludge or soil makes EXTRACT a natural, low-cost choice for the rehabilitation of canals, harbors, recreational areas and contaminated sites. The system is also used to process sludges from sewage treatment plants and tank bottoms.

First developed for petroleum drilling projects, the EXTRACT sludge and soil treatment system has been used for over seven years at various contaminated sites, and for water treatment plant sludges. The system is widely recognized in Europe as incorporating exceptional expertise in the field of contaminated sludge and soil treatment.

Limitations: Does not remove contaminants but concentrates them in the fine fraction.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

$30.00 US/m³ - $60.00 US/m³ (150 FF/m³ to 300 FF/m³) for treatment of in situ sediment.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Extract S.A.
Zone Industrielle de Mitry-Compans
Mitry-Mory,
France 77290-
Notes

Contact: Benaddou, R.
Phone: 33164672727 Ext:
Fax: 33164673434
Email:

Vendors:

Extract S.A.
Zone Industrielle de Mitry-Compans
Mitry-Mory,
France 77290-
Notes

Contact: Benaddou, R.
Phone: 33164672727 Ext:
Fax: 33164673434
Email:

Literature References:

Author: **Benaddou, R., Roudier, J-P.**
Title: La Réhabilitation des Sites Aquatiques
Journal: L'Eau, L'Industrie, Les Nuisances 182 Date: **Jan 1995**

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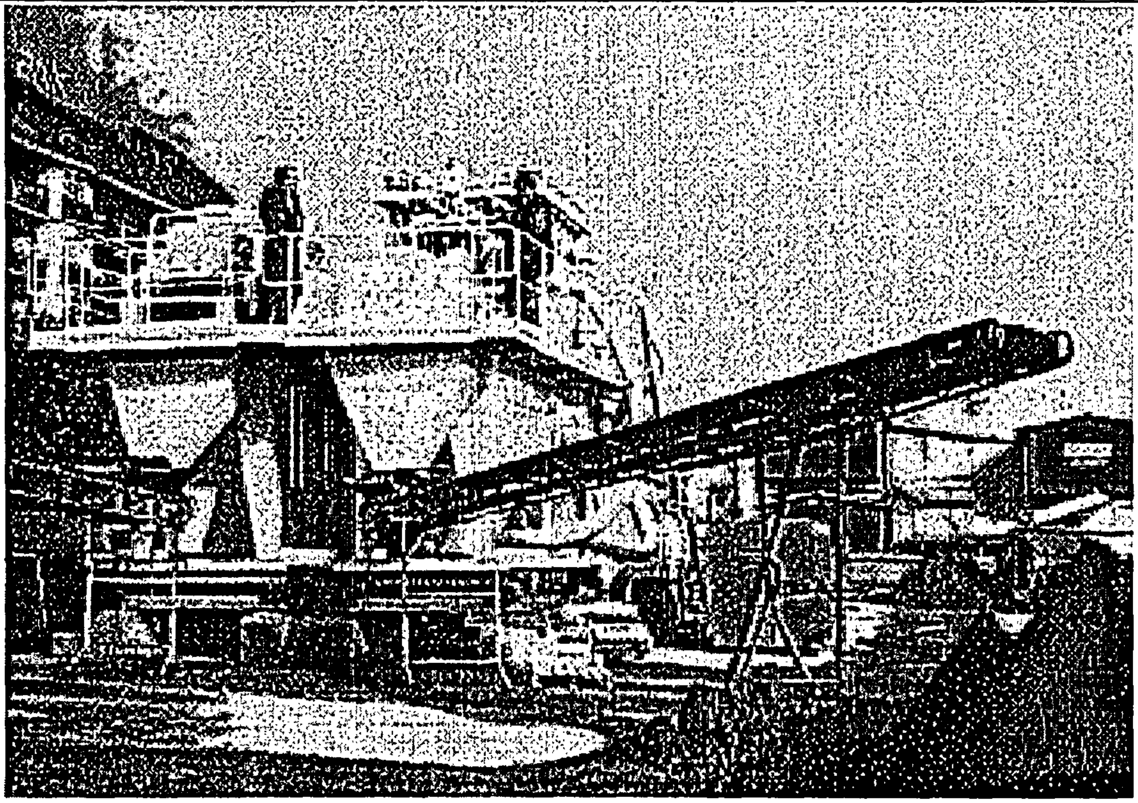
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Extract S.A., EXTRACT System

29-Dec-97



Project: Bains des Paquis

Location: Geneva, Switzerland

Year: 92

Commercial

Client/Funding Agency	Contact	Phone
City of Geneva	Mr. Barrere	(19) 41.22.341.90.10

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$): $2,000,000.00

Setup Time (days):

Breakdown Time (days):

Media Treated: Mud and sediment.

Contaminants Treated:

Emissions/ByProducts:

Description: This project involved the dredging and treatment of 6000 m³ of material.The treatment of the sediments occurred in 4 phases (1) the sediment was screened to remove material greater than 4 mm in size; (2) the sand was put in a hydrocyclone, dewatered and stored for future re-utilization; (3) the remaining mud was homogenized, and compacted; (4) the water by-product was cleaned and ready to be discharged to the lake.

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Exxon Chemical Oxidation/Cyanide Destruction Process

29-Dec-97

Technology Type: Chemical

TechID: 47

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☐

Description:

95% pure chlorine dioxide is generated on site for use as an oxidizing agent. The targetted organic contaminants form salts and non-toxic organic acids when oxidized by the chlorine dioxide. The dosage required depends upon the concentration of target and non-target oxidizable materials in the waste stream.

Depending upon the water content of the waste matrix, the chlorine dioxide may be metered directly into a process waste stream or applied in-situ through well injection (ie. soil).

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Exxon Chemical Company
4510 East Pacific Coast Highway
Long Beach, CA
USA 90804-

Contact: Kurpakus, T.
Phone: (310) 597-1937 Ext:
Fax: (310) 597-1755
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Facet Quantek Coalescing Plate Separator

30-Dec-97

TechID: 48

Technology Type: Post Treatment, Pre Treatment

Contaminants Treated:

Media Treated: Suspended Sediments

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The Quantek plate separator consists of vertically set corrugated plates. The technology is designed to seperate oil and solid particles from the water phase. Slurries with up to 1000 mg/L of solids may be treated.

The contaminated liquid stream enters the plate separator and during passage through the unit, oil rises and solids sink to accumulate on dedicated surfaces. All surfaces are sloped a minimum of 45 degrees. The plates are constructed of a smooth, oleophilic material to allow for maximum coalescing of oil and settling of solids. Once sufficient buildup of the oil (or solids) occurs to break the surface tension (or friction) the oil (solids) will rise (fall) to the surface (base) of the reactor.

Limitations:

Efficiency Description: 30 ppm residual oil content

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.75

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Oil, solids, water

Developers:

Facet Quantek, Inc.
2929 E. Apache, P.O. Box 50096
Tulsa, OK
USA 74150-0096
Notes

Contact: Mohr, K.
Phone: (918) 834-2929 Ext:
Fax: (918) 836-7383
Email:

Vendors:

Baldwin Industrial Systems, Pty. Ltd.
16/10 Yalgar Road
Kirrawee, N.S.W.
Australia 2232 -
Notes

Contact:
Phone: Ext:
Fax:
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

FSCL Fujibeton

30-Dec-97

TechID: 88

Technology Type: Stabilization/Fixation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Japan **Portable:** ☒

Description:

Fujibeton is a compound, developed in Japan, which when added to Portland cement is capable of solidifying wastes. The end product exhibits properties similar to regular concrete with improved hardness, durability, permeability and watertightness.

A component of the chemical mix promotes the penetration of cement into the pore spaces of the material being treated. In addition, the chemical is a strong wetting agent which enables ready mixing of the cement with water in the pores.

As the reaction is low heat generating, the VOC remains largely within the solidified matrix.

The technique has been utilized extensively in Japan on dredged sediment for pollution control and the resulting solids have passed U.S. EPA Toxicity tests.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solidified waste

Developers:

Fujimasu Synthetic Chemical Laboratories

Tokyo,
Japan

Notes

Contact: Fuijimasu, J.
Phone: Ext:
Fax:
Email:

Vendors:

Jones Environmental Sciences Inc.

1199 West Pender, Suite 408
Vancouver, BC
Canada V6E2R1

Notes Vendor for Fujimasu Synthetic Chemical Laboratories

Contact: Jones, David
Phone: (604) 669-7393 Ext:
Fax: (604) 682-7354
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

General Atomics Circulating Bed Combustor Incinerator

30-Dec-97

Technology Type: Incineration

TechID: 80

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

GA'S Circulating Bed Combustor (CBC) uses high velocity air to entrain circulating solids in a highly turbulent combustion loop for the efficient destruction of hazardous contaminants. Relatively low operating temperatures of 1450-1600 degrees F reduces both potential thermal NOx emissions and operating costs. High turbulence produces a uniform temperature around the combustion chamber and hot cyclone, returning circulating solids to the combustion chamber and promoting complete mixing of the waste material. Effective mixing and relatively low combustion temperatures reduce emissions of CO and NOx. Hot gases produced during combustion pass through a convective gas cooler and baghouse before being released to the atmosphere.

The CBC is constructed of truck-size modules and designed for simple, rapid field assembly. It can treat solids, liquids, sludges and gases, however all feed must be less than 1 inch.

Limitations:

Efficiency Description: >99.99% for a variety of hazardous contaminants and 99.9999% DRE for PCBs

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals U.S. EPA TSCA permits for PCB burning in all 10 EPA regions; Accepted into the SITE Demonstration Program in March 1989.

Setup/Feed: Setup Time (days): **65** Breakdown Time (days): **50**

Feed Rate Average (Tonne/hr): **2**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$100.00 – $175.00** Average Cost (US$/Tonne): **$137.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solids - residues of bed and fly ash; stack gas - filtered for particulate to meet local air pollution control requirements

Developers:

General Atomics
3550 General Atomics Court
San Diego, CA
USA 92121-1194
Notes

Contact: Broido, J.
Phone: (619) 455-4495 Ext:
Fax: (619) 455-4111
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Gorman Incineration

30-Dec-97

TechID: 92

Technology Type: Incineration

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☐

Description:

Sister company, Gorman Paving Ltd. and the New Brunswick MOE developed and installed incineration equipment for remediation and desorption of contaminated soils. This installation has now been operational for two years and has proven to be very successful.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Approved by N.B. MOE

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Gorman Paving Ltd.

Fredericton, NB
Canada
Notes

Contact:
Phone: Ext:
Fax:
Email:

Vendors:

Ashwarren International Inc.

1398 Cartwright St., Granville Isl.
Vancouver, B.C.
Canada V6J 4N1
Notes

Contact: McDowell, T.
Phone: (604) 684-5111 Ext:
Fax: (604) 683-2331
Email:

Ashwarren International Inc.

72 Ashwarren Rd.
Downsview, ON
Canada M3J1Z6
Notes

Contact: Rivett, Mark
Phone: (416) 633-9670 Ext:
Fax:
Email:

Literature References:

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GPEC, Hazardous Waste Fixation/Stabilization

30-Dec-97

Technology Type: Stabilization/Fixation TechID: 283

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Heavy Metals, Mercury, Halogenated Organics

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

This unique patented fixation/stabilization technology can be used for both in-situ and ex-situ treatment of contaminated soils, sludges, and sediments. It is a proven effective technology that has been utilized to remediate over 750000 tons of complex hazardous wastes, and has been successfully implemented at sites involving up to 100000 cubic yards of waste, including full scale Superfund remediation projects. Unlike conventional solidification technologies, this fixation/stabilization process treats a wide variety of both organic and inorganic hazardous wastes including: coal tar, heavy metals, polycyclic aromatic hydrocarbons (PAH's), polychoroinated biphenyls (PCB's), pentachlorophenol (PCP), and pesticides. The chemical reagents used in this technology bond and encapsulate the contaminants using a unique compound that absorbs as much as twenty times its own weight in contaminated waste. The reagents solidify the contaminated material to form a highly insoluble monolith of treated waste, that prevents the contaminants from re-entering the environment. Waste treated using this technology can meet and exceed the requirements of all currently accepted leachability tests.

Limitations:

Efficiency Description:

Government Funding: SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 21 Breakdown Time (days): 14

Feed Rate Average (Tonne/hr): 50

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $100.00 – $125.00 Average Cost (US$/Tonne): $110.00

Average cost $100-$125 + dewatering costs. Contaminant PCP. Initial level 5000 ug/g. Final level 1 mg/l (leachate conc.). Total amount of material treated: 15000 - 20000 tons.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Silicate Technology Corporation
7655 East Gelding Drive, Suite B-2
Scottsdale, AZ
USA 85260-
Notes

Contact: Pelger, Stephen
Phone: (602) 948-7100 Ext:
Fax: (602) 991-3173
Email:

Vendors:

Green Plan Environmental Corporation
2880 Sheffield Road, Unit 3
Ottawa, ON
Canada K1B1A4
Notes

Contact: Perera, Noel
Phone: (613) 747-1788 Ext:
Fax: (613) 747-0520
Email:

Literature References:

Author: **Editors of Environment Today**
Title: Site Remediation: 10 "can do" technologies
Journal: Environment Today Date: **Jun 1991**

Author: **Bates, Edward**
Title: Successful Stabilization of Organics
Journal: Tech Trends Date: **Mar 1992**

Author: **Larsen, Scott, Maupin, Greg**
Title: New Tactics to Beat contaminants in Waste
Journal: Environment Strategy America Date: **Jan 1995**

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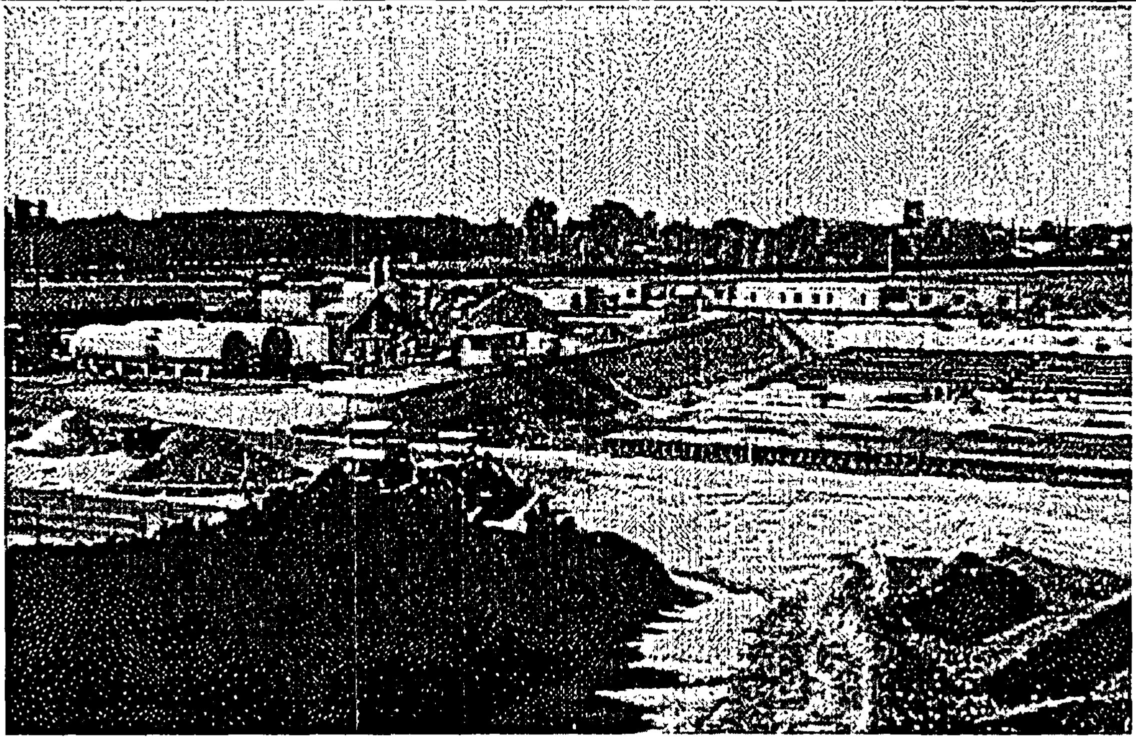

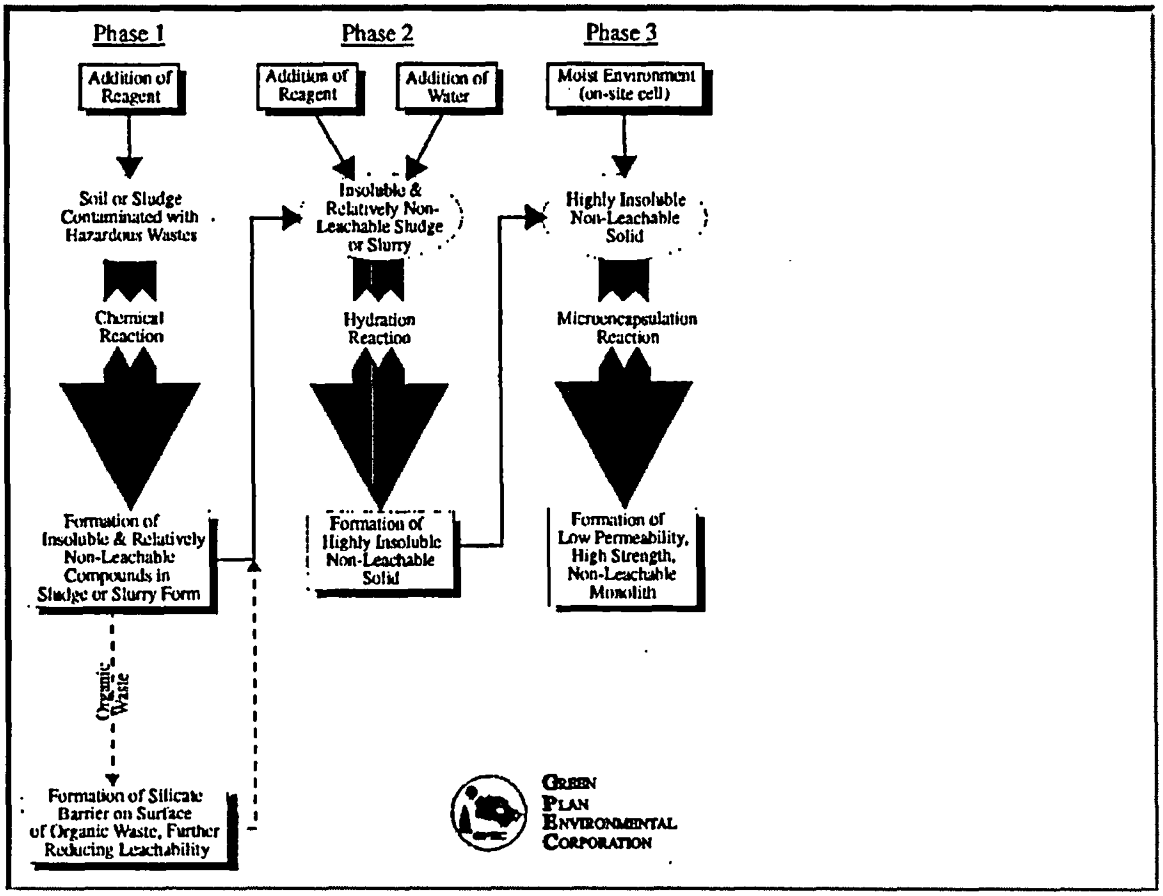

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Project: Tacoma Historical Coal Gasification Superfund Site **Year: 93**

Location: Tacoma, WA Full Scale Demo

Client/Funding Agency	Contact	Phone
Washington Natural Gas Co.	Mr. Harry Shapiro	(206) 272-5723

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PAH's

Emissions/ByProducts:

Description: Project monitored by the USEPA. Successful full scale stabilization of contaminated soils from a former coal gasification plant and operating metal recycling facility. Treated material stockpiled and utilized as a cap for the site.

Project: Selma Pressure Treating Superfund Project **Year: 92**

Location: Selma, CA Full Scale Demo

Client/Funding Agency	Contact	Phone
Chemical Waste Management	Mr. August Achabauer	(510) 249-4604

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PCP; Arsenic; Chromium

Emissions/ByProducts:

Description: EPA lead project administered by the US Army Corps of Engineers for contaminated soils from an operating wood preserving facility. Technology successfully utilized to treat both organic and inorganic contamination. Treated material was placed in an on-site repository.

Project: East Palo Alto, CA Remediation Project **Year: 92**

Location: East Palo Alto, Ca Commercial

Client/Funding Agency	Contact	Phone
Rhone Poulenc	Mr. Philip Di Gasbarro	(609) 860-3117

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Arsenic; Cadmium

Emissions/ByProducts:

Description: Project was the site of an arsenic based pesticide manufacturing facility, situated directly adjacent to San Francisco Bay. In-situ techniques were used to treat areas below groundwater level and ex-situ techniques used in shallower areas. Contaminated soil was successfully stabilized with 100% of samples meeting TCLP leachate criteria.

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GPEC, Low Temperature Thermal Desorption

30-Dec-97

TechID: 282

Technology Type: Thermal

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Low Temperature Thermal Desorption (LTTD) is a mobile treatment technology for the remediation of hydrocarbon contaminated soils and sediments. GPEC operateds several LTTD units, each contained on one standard sized transport trailer, which can be readily mobilized to virtually any sized site.

The contaminated soil is fed into a hopper, equipped with a screen to remove boulders and large debris. From the hoper, the soil is conveyed over a weigh scale and into a rotary kiln. Within the kiln, the soil is heated to temperatures which induce the vapourization of the hydrocarbon compounds. The treated soil is discharged and stockpiled for backfilling.

The hydrocarbon contaminated off-gases are forced through a baghouse to remove particulate matter, heated with a second burner and then routed to the off-gas treatment system. GPEC's LTTD units are equipped with a patented catalytic oxidizer for the treament of off-gases, which operates at much lower temperatures than a conventional afterburner, and destroys the hydrocarbons at an extremely high efficiency.

The LTTD process removes and destroys the contaminants and does not generate any wastes or by-products which require off-site disposal.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Licensed to operate in numerous provinces and states (in US).

Setup/Feed: Setup Time (days): **1** Breakdown Time (days): **1**

Feed Rate Average (Tonne/hr): **45**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$40.00 – $50.00** Average Cost (US$/Tonne): **$45.00**

Contaminant BTEX . Initial level 1,350. Final level non-detectable. Total amount of material treated 5000 tonnes. Treatment cost $40.00 - $50.00/tonne (US$).

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Ryan Murphy Inc.
8774 Yates Drive, Suite 100
Westminster, CO
USA 80030-
Notes

Contact: Murphy, Dennis
Phone: (303) 427-4567 Ext:
Fax: (303) 427-1955
Email:

Vendors:

Green Plan Environmental Corporation
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Ottawa, ON
Canada K1B1A4
Notes

Contact: Perera, Noel
Phone: (613) 747-1788 Ext:
Fax: (613) 747-0520
Email:

Literature References:

Author: **Johnson, Marc**
Title: LTTD Remediation of Hydrocarbon Contaminated Soil at remote and Cold Climate Sites
Journal: Technologies and Techniques for Hydrocarbon Remediation in Arctic Climates : Proceedings Date: **Jun 1995**

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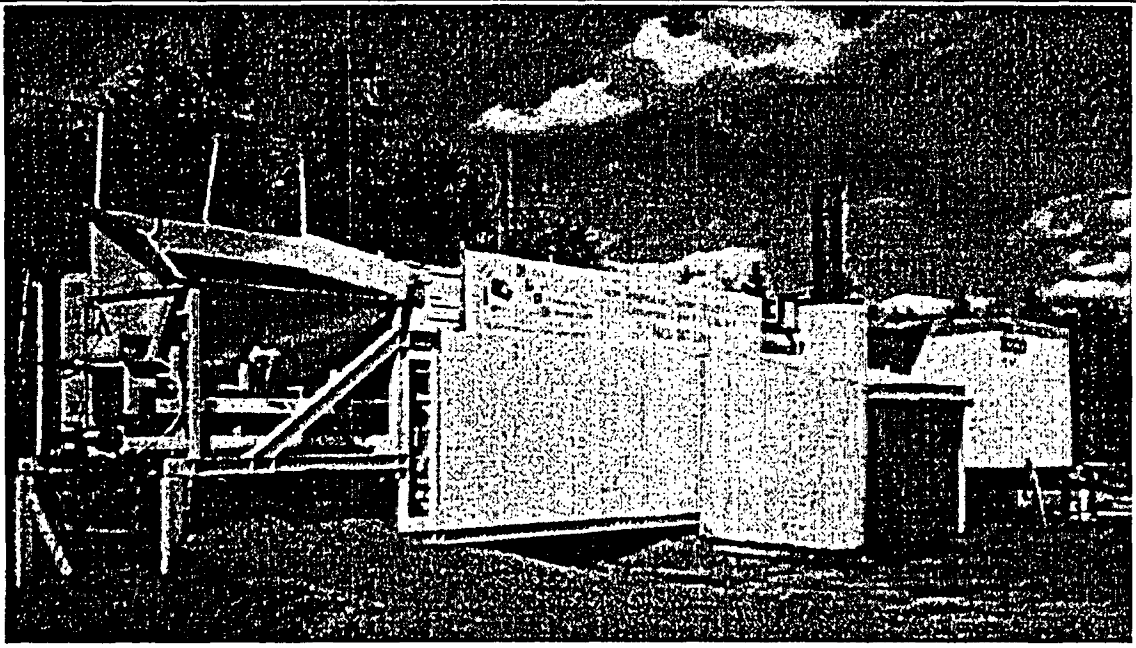

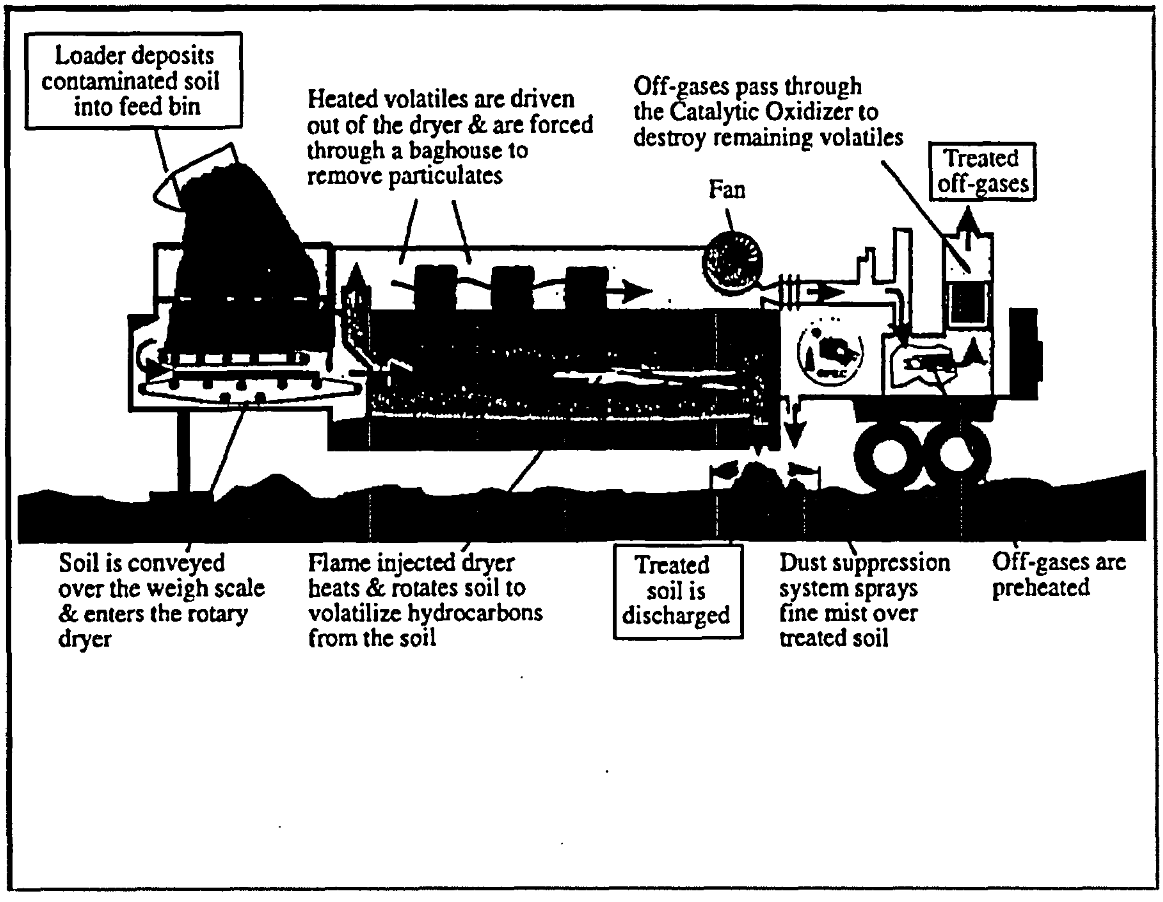

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Project: LTTD Remediation in Northern Ontario **Year: 94**

Location: Sault Ste. Marie, ON

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: BTEX, TPH

Emissions/ByProducts:

Description: 10000 tonnes of soil contaminated with various petroeum products were remediated under extreme winter conditions at this site in Northern Ontario. Both saturated and unsaturated soils were treated. Soil and groundwater assessment activities were conducted as well.

Project: Contaminated Delineation and LTTD Remediation of S **Year: 94**

Location: Ontario Commercial

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: TPH

Emissions/ByProducts:

Description: Approximately 2800 tonnes of hydrocarbon contaminated soil was excavated and remediated using one of GPEC's mobile Low Temperature Thermal Desorption (LTTD) units. Although this was a remediation project, GPEC, in conjunction with Environment Canada, was also responsible for contamination delineation adn confirmatory sampling and analysis to ensure that treated soil was remediated to below criteria. At one of the sites, approximately 100 tonnes of soil was excavated, screened, and treated operating under winter conditions including hail, ice rain, snow, -30°C temperatures, and windgusts to 70 km/hr. GPEC successfully operated 24 hours per day without disturbance to surrounding neighbours at sites as small as 60 m x 60 m, and as close as 100 m to a residence. CCME protocols and Environment Canada's TAB's were adhered to throughout the project.

Project: LTTD Remediation of DND owned Fire-Fighter's Train **Year: 94**

Location: Quebec, Quebec Commercial

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: oil and grease, BTEX

Emissions/ByProducts:

Description: This was the first LTTD project to be undertaken in the province of Quebec. The original scope of work was completed a number of months ahead of schedule and within budget. The project also included the remediation of contaminated water using granular activated carbon (GAC) and the removal of storage tanks. Although this was a remediation project, site assessment activities including on-site analysis were required throughout the project. Contaminants of concern included BTEX and TPH.

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Grace Dearborn, Cycled Daramend Bioremediation

30-Dec-97

TechID: 326

Technology Type: Biological

Contaminants Treated: Pesticides/Herbicides, Halogenated Organics, Explosives

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The Cycled DARAMEND technology represents a patented modification of the DARAMEND soil bioremediation technology, for which Dearborn is the worldwide licensee. The aerobic bioremediation technology utilizes organic (DARAMEND products) and inorganic (i.e. nutrients, pH modifiers) amendments to optimize the activity of microorganisms indigenous to a soil or waste resulting in natural destruction of organic contaminants. No microbial inoculation is required. A wide range of wastes and contaminants have been demonstrated to be amenable to remediation using DARAMEND. Up to 3,500 tonnes (3,900 tons) of waste have been treated in a given batch. As well as reducing chemical concentrations, DARAMEND significantly reduces waste toxicity (i.e. to plants and earthworms).

The technology modification targets organic contaminants such as organochlorine pesticides that often degrade slowly under aerobic conditions. The modified technology involves the imposition of anoxic and oxic conditions to sequentially reductively dechlorinate complex chlorinated organics and aerobically degrade the (partially) dechlorinated breakdown products including volatile fatty acids.

Anoxic conditions are created through addition of DARAMEND amendments, other organic amendments and inorganic amendments (multivalent metals) and water. The DARAMEND amendments stimultate the biological depletion of oxygen within the soil matrix by the aerobic and faculative microbial populations. Oxygen renewal is limited to diffusion as a result of the soil pores being nearly full of water. The multivalent metal allows a specific redox level to be achieved. All the amendments are naturally occurring, non-hazardous materials.

The oxic conditons are created by reducing the saturation of the soil. This may be accomplished through natural evaporation, enhanced by tilling, as well as by increasing the soil water holding capacity through addition of DARAMEND amendments.

At large-scale the Dearborn approach to bioremediation is generally applied as a landfarming process. Contaminated soil and amendments are blended using a rotary tiller with an effective penetration of 0.6 m. The rotary tiller is driven by an agricultural tractor. The tilling serves to homogenize the amended soil and also to aerate the soil when aerobic conditions are targeted. Water content is one critical process parameter and is adjusted using agricultural irrigation equipment. A cover (i.e. tarpaulin and/or greenhouse) may be used to prevent the addition of water from precipitation events and to minimize evaporation at other times. The cover negates the requirement for a leachate collection system as the soil or water being treated is maintained below saturation.

Application of the Cycled DARAMEND technology targeting chlorinated pesticides (primarily DDT and Toxaphene) began in South Carolina late in 1995. The technology is being applied to surficial soil (uuper 0.6m) in-situ. Two additional projects were to commence in Ontario, Canada during 1996.

Limitations: As the treatment is biological, successful application is limited to media that, following addition of the DARAMEND amendment, are non-toxic to the target-compound degrading biomass. Other than excessive concentrations of the target contaminant(s), as alluded to above, extremes in heavy metal concentrations, pH or anion/cation concentrations could limit treatment effectiveness.

Land area requirements are large, although less than traditional land farm approaches, due to 0.6 m (2 ft) treatment depth.

Efficiency Description: 85 %

Government Funding: DESRT, ETP

Environmental Concerns: Air quality at the treatment area should be assessed at each application as a protective measure for site personnel. The treatment area is usually lined and covered to eliminate concerns regarding run-off and leachate.

Health & Safety Plan Available: ☐

Regulatory Approvals Approved for site specific application by South Carolina Department of Health and Environmental Control.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $75.00 – $200.00 Average Cost (US$/Tonne): $125.00

Assuming 10,000 tonnes; soil as media; contaminant DDT; Untreated level - 200 ug/g dry; Treated level - 30 ug/g dry.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Potential air emissions (VOC's); debris

Developers:

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Grace Dearborn, Cycled Daramend Bioremediation

30-Dec-97

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Fax: (905) 279-0020
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Notes

Contact: Seech, Alan
Phone: (905) 279-2222 Ext:
Fax: (905) 279-0020
Email:

Literature References:

Author: **Bucens, P.G., Seech, A.G.**
Title: Chlorinated Pesticide Degradation Using Reductive Dechlorination
Journal: Waste Business Magazine, Vo. 6, No.5 Date: **Jan 1995**

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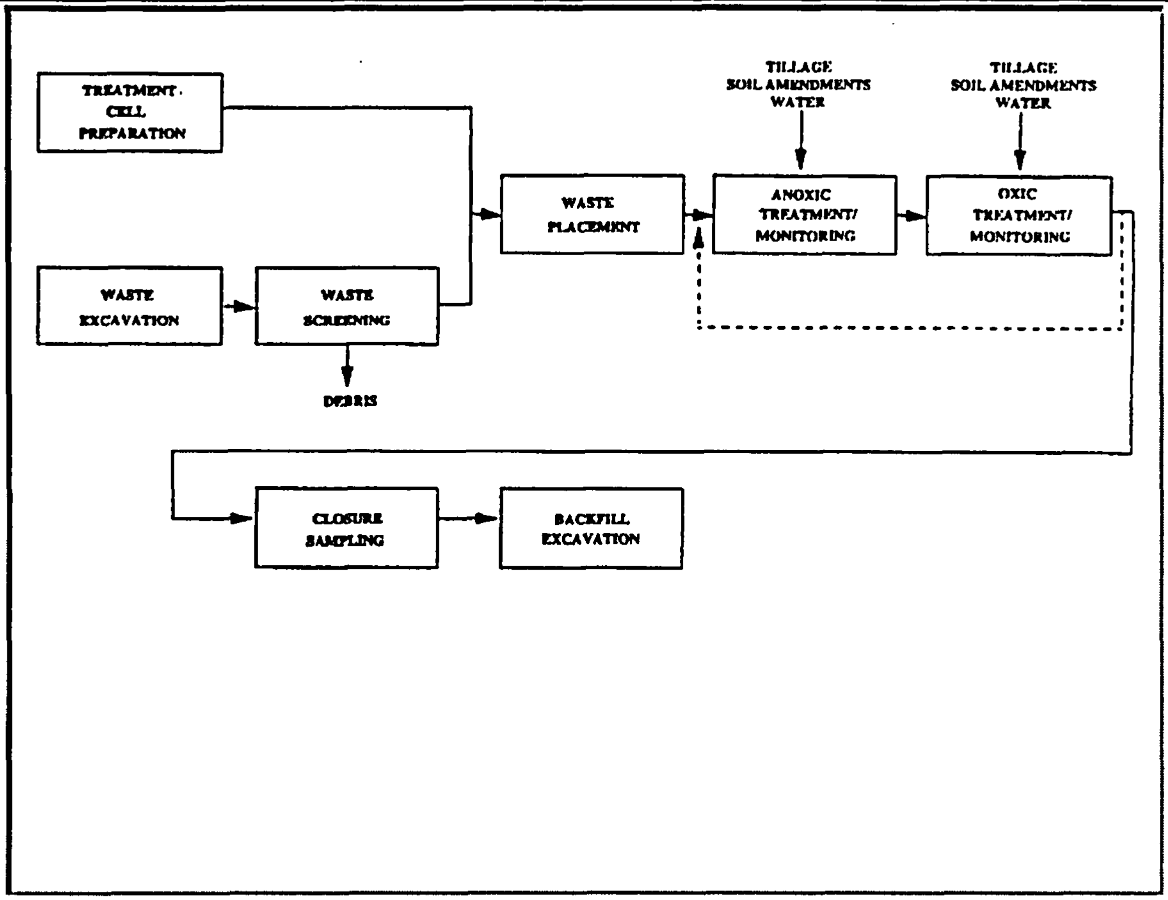
Grace Dearborn, Cycled Daramend Bioremediation

30-Dec-97



Project: Reductive Dechlorination... **Year: 93**

Location: ,Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Environment Canada	Lisa Keller	(819) 953-0962
MOEE	G. Castonguay	(416) 323-5214

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Soil

Contaminants Treated: Not available.

Emissions/ByProducts:

Description: Bench scale optimization and field scale validation of Dearborn's reductive dechlorination of chlorinated pesticides and herbicides. Field piloting is being initiated during 1996.

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Grace Dearborn, Daramend Bioremediation

30-Dec-97

Technology Type: Biological

TechID: 51

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The DARAMEND technology has been developed from concept to field-scale application over the last decade. Initial development, funded by the Government of Canada, focused on the bioremediation of soil contaminated by organic wood treatment chemicals, principally pentachlorophenol (PCP) and PAH's. The technology has since been successfully applied to batches of soil up to 3,500 tonnes (3,900 tons).

The key concept of DARAMEND, a family of organic and inorganic soil amendments, is to improve the physical and chemical environment within the contaminated matrix to optimize growth conditions for the indigenous microorganisms. The amendments are naturally existing non-hazardous materials specifically prepared for given soil and contaminant combinations. The nature of the DARAMEND amendments is such that they are not required by regulation to have Worker Hazardous Materials Information Sheets. The technology IS NOT an inoculation technology. When thoroughly incorporated to the soil, the amendments:

* enhance air and water advection through the treated soil mass;
* increase the soil's ability to hold biologically available water;
* act as a source of organic and inorganic nutrients;
* provide a growth surface for microorganisms; and
* transiently bind contaminants, reducing acute toxicity of the soil.

In the field, the DARAMEND technology has been implemented as a landfarm in-situ (surficial 0.6 m, 2' 0"); ex-situ in lined landfarm cells; and ex-situ in biopiles. In all instances the following steps are required:

* screening to remove material larger than 0.1 m (0' 4");
* application of DARAMEND and other requisite amendments (i.e. nutrients and pH adjusting chemicals) to the soil surface. DARAMEND amendments are generally added at LESS THAN 5% wt./wt.;
* intense mixing/homogenization of the amendments and soil by roto-tilling. The roto-tiller traditionally used at this and later stages of landfram operations has an active tillage depth of 0.6 m (2' 0"); and
* monitoring of process control parameters (primarily soil moisture content and pH), irrigation and aeration. Note that in landfarm application aeration is provided by roto-tilling, while for pile applications aeration is provided by forced air flow.

Grace Dearborn has demonstrated DARAMEND's ability to effectively detoxify soil contaminated by elevated levels of total petroleum hydrocarbons, TPH, (up to ca. 10,000 mg/kg), PAH's (up to ca. 20,000 mg/kg) and chloricated phenols (up to ca. 2,000 mg/kg). Residual concentrations commonly achieved are 100 mg/kg TPH, 100 mg/kg PAH's and 5 mg/kg PCP. Treatment times are generally less than one year per batch of soil.

Complementing the reductions in chemical concentrations achieved, toxicity testing information shows that DARAMEND biormediation results in treated soil which is healthy for soil biota and supports the growth of agricultural plants. In fact, testing conducted by an independent laboratory found little difference in the toxidity of DARAMEND treated soil and uncontaminated agricultural soil.

Limitations: As the treatment is biological, successful application is limited to media that, following addition of the DARAMEND amendment, are non-toxic to the target-compound degrading biomass. Other than excessive concentrations of the target contaminant(s), as alluded to above, extremes in heavy metal concentrations, pH or anion/cation concentrations could limit treatment effectiveness.

Land area requirements are large, although less than traditional land farm approaches due to a 0.6 m (2 ft) treatment depth. The land requirement may be further reduced through implementation of a biopile system when possible and economical.

Efficiency Description:

Government Funding: Great Lakes Cleanup Fund, DESRT, SITE, ETP

Environmental Concerns: Air quality at the treatment area should be assessed at each application as a protective measure for site personnel. The treatment area is usually lined and covered to eliminate concerns regarding run-off and leachate.

Health & Safety Plan Available: ☒

Regulatory Approvals Approved for site specific application by New Jersey Department of Environmental Protection, Minnesota Pollution Control Agency, Ontario Ministry of Environment and Energy, British Columbia Ministry of Environment, Lands & Parks, Manitoba Environment, New Brunswick Environment.

Setup/Feed: Setup Time (days): 30 Breakdown Time (days): 30

Feed Rate Average (Tonne/hr): 6

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $54.00 – $110.00 Average Cost (US$/Tonne): $75.00

Assuming contaminant PAH's; 10,000 tonnes material treated; ex-situ; Initial contaminant level 1,000 ug/g dry; Final contaminant level 100 ug/g dry; initial moisture content ca. 50%. Rate

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average: Batch.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Potential Air Emissions (VOC's); Debris

Developers:

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Contact: Seech, Alan
Phone: (905) 279-2222 Ext:
Fax: (905) 279-0020
Email:

Literature References:

Author: **Seech, A.G.**
Title: Bioremediation of Sediments Contaminated with Polynuclear Aromatic Hydrocarbons (PAH's) and Pentachlorophenol (PCP)
Journal: Hazardous Material Management
Date: **Jan 1993**

Author: **Seech, A.G., Marvan, I.J., Trevors, J.T.**
Title: On-Site/Ex Situ Bioremediation of Industrial Soils Containing Chlorinated Phenols and Polycyclic Aromatic Hydrocarbons ,
Journal: In-Situ /On-Site Bioreclamation : An International Symposium
Battelle Institute, San Diego, California, USA
Date: **Jan 1993**

Author: **Bucens, P.G., Marvan, I., Seech, A.G.**
Title: Amendments Speed Degradation of Heavier Hydrocarbons
Journal: Soils Magazine
Date: **Jan 1994**

Author: **Grace Dearborn Inc.**
Title: Pilot-Scale Demonstration of Daramend Enhanced Bioremediation of Sediment Contaminated with Polycyclic Aromatic
Journal: Hydrocarbons: Hamilton Harbour, Ontario
Prepared for Great Lakes Cleanup Fund
Date: **Aug 1994**

Author: **Bucens, P.; Seech, A.; Marvan, I.**
Title: Pilot Scale demonstration of Grace Dearborn Inc.'s DARAMEND Bioremediation Technology to Remediate PAH
Journal: Contaminated Sediment from Hamilton Harbour, Ontario
Sediment Remediation '95 Poster
Date: **May 1995**

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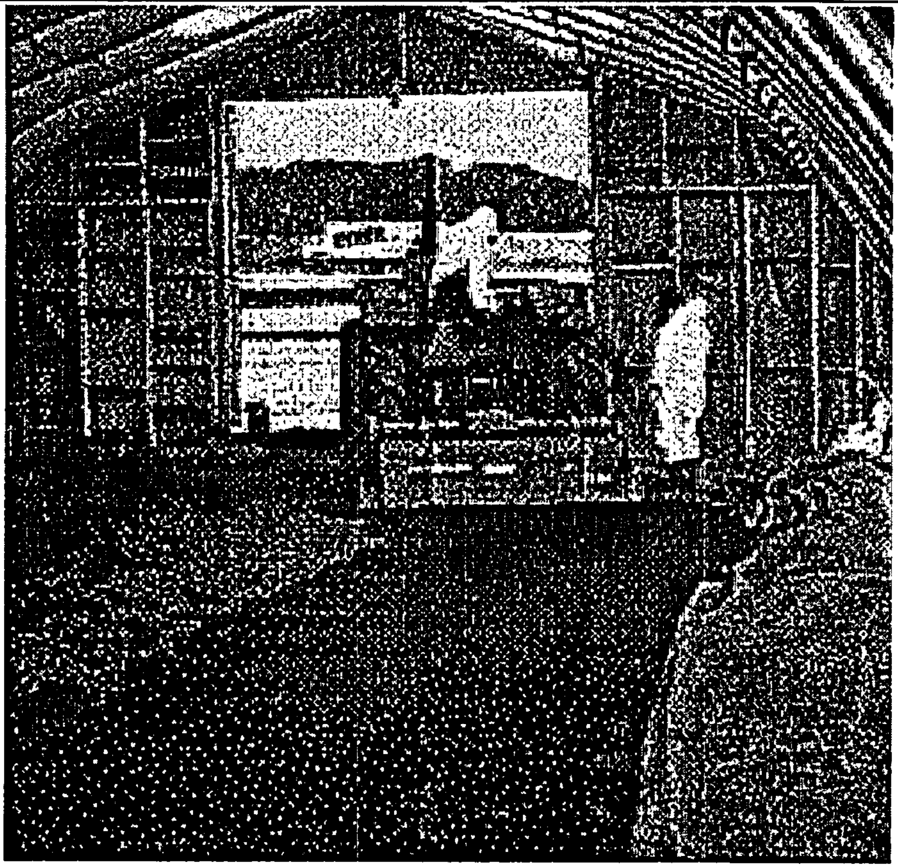
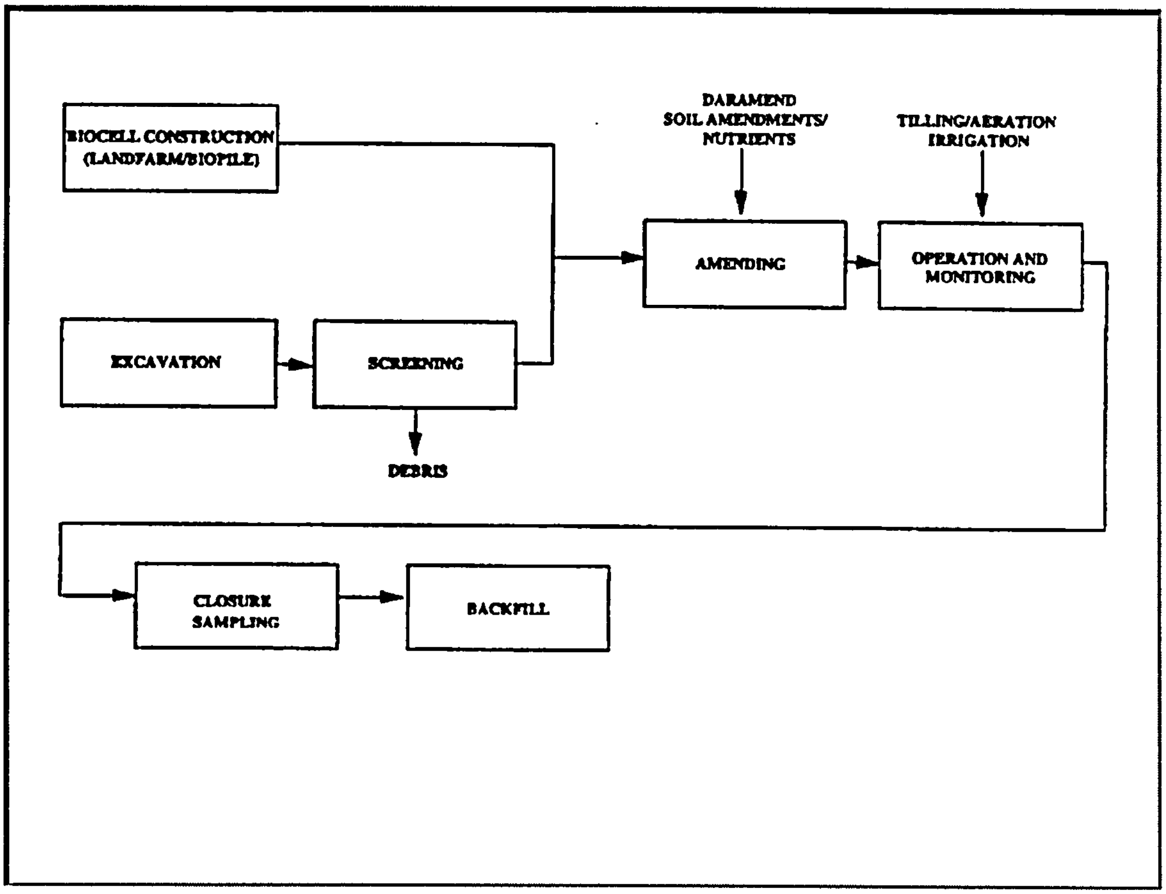
Grace Dearborn, Daramend Bioremediation

30-Dec-97





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Grace Dearborn, Daramend Bioremediation

30-Dec-97

Project: Domtar Trenton-Full Scale Remediation **Year: 93**

Location: Trenton, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
Domtar Inc.	B. Watson	(514) 457-8209
Environment Canada	Lisa Keller	(819) 953-0962
MOEE	Ed Rodrigues	(416) 314-4197

*** Audited *** Auditing Agency: Kevin Hosler, Water Technology International Phone: (905) 336-6021

Feed Rate (Tonne/hr): 6.25 Amount Treated (Tonne): 1500

Treatment Cost (US$): $150,000.00

Setup Time (days): 21 Breakdown Time (days):

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:
PAH's	439 mg/kg	144 mg/kg	67
CP's	157 mg/kg	14 mg/kg	91
PAH's	619 mg/kg	79 mg/kg	87
CP's	102 mg/kg	2 mg/kg	98

Clean-up goals: CCME, PCP in soil 5 mg/kg; PAH's in soil - species specific 10 to 100 mg/kg.

Emissions/ByProducts: Screened out debris.

Description: Full-scale demonstration (3,500 tonne In-Situ, not referenced above, and Ex-Situ) DARAMEND bioremediation at former Domtar Inc. Wood Preserving Site.

Project: Daramend Bioremediation of Manufactured Gas Plant **Year: 93**

Location: Vancouver, British Columbia, — Pilot Scale

Client/Funding Agency	Contact	Phone
BC MELP	J. Wiens	-
Environment Canada	L. Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 100

Treatment Cost (US$):

Setup Time (days): 30 Breakdown Time (days): 30

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
PAH's	659 mg/kg	106 mg/kg	84

Clean-up Goals: BC level C- PAH's < 200 mg/kg combined with species specific targets.

Emissions/ByProducts: Screened out debris

Description: Ex-Situ landfarming Bioremediation Project utilizing the DARAMEND technology.

Project: Hamilton Harbour Project **Year: 92**

Location: Hamilton, Ontario, Canada — Pilot Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund (COSTTEP)	Craig Wardlaw	(905) 336-4691

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4665

Feed Rate (Tonne/hr): Amount Treated (Tonne): 150

Treatment Cost (US$): $240,000.00

Setup Time (days): 30 Breakdown Time (days): 10

Media Treated: The sediment in the highly contaminated areas is very oily and black. The oily material is generally referred to as "coal tar" although it is actually a mixture of coal tar, coal dust and other organic contaminants. The sediment is fine grained with a small proportion of debris (mainly iron ore nuggets).

PAHs	800 - 2000 mg/kg
Total organic carbon	10 - 30 %

Metals:

Zinc1000	3000 mg/kg

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Grace Dearborn, Daramend Bioremediation *30-Dec-97*

Lead	100 - 600 mg/kg
Iron	2 - 20 %

In laboratory bioassay tests the raw sediment kills all benthic and aquatic organisms within a few hours.

Contaminants Treated: Total PAH's Untreated: 1139 ug/g Treated: 110 ug/g 90.3 % removal

Emissions/ByProducts: Air monitoring slowed naphthalene concentrations above air quality criteria. For full scale treatment an air control system would be required.

Description: Dearborn is a Canadian subsidiary of Grace Chemical (U.S.) and is located in Mississauga, Ontario. The Dearborn technology is best described as "pad farming". Sediment to be treated was spread out on a specially constructed treatment pad which prevents the escape of contaminants to the surrounding or underlying soil. The pad was lined with an impermeable plastic liner and the liner was covered with a layer of clean sand. Sediment was placed on top of the sand and allowed to dry to roughly 30% water. The pad was covered with a polyethylene greenhouse. Bacteria from the sediment were cultivated in the laboratory and subjected to bench scale tests to determine their ability to degrade organic contaminants. In this case the natural bacteria in the sediment were found to be excellent degraders of Polycyclic Aromatic Hydrocarbons and no additional bacteria were added. Dearborn added nutrients and a specially prepared organic amending agent which gave "body" to the sediment. The amending agent allows the sediment to hold more water and air, both of which are critical to the success of bioremediation. The sediment is mixed using common agricultural tillage equipment once every two weeks.

For this demonstration it was planned to treat two different types of sediment from Hamilton Harbour. Approximately 85 cubic metres of untreated sediment and 50 cubic metres of sediment pre-treated with calcium nitrate were dredged. The sediment pre-treated with calcium nitrate was from a site in the Harbour which had been injected with the calcium nitrate by the Limnofix In-Situ treatment. As well two distinct control areas of roughly 2 cubic metres each were to be set up on the treatment pad. The first was an untilled and unamended control. The second was a tilled but unamended control.

Sediment was received in October of 1992 and was treated through to December 1993. Treatment was conducted in an engineered treatment cell covered by a Quonset type greenhouse. The treatment pad was constructed on vacant industrial land at Pier 26 donated by the Hamilton Harbour Commissioners. Sediment was placed in the treatment pad by trucks which were loaded dockside at Pier 26.

RESULTS

Despite the sampling problems the Grace Dearborn project has to be considered a huge success. The overall level of PAHs in the sediment was reduced from over 1100 ppm to under 100 ppm. Phototoxicity testing was conducted by studying the success of germination of tomato plants. The germination rate of tomato seeds in the treated sediment was markedly better than that of those in the control sample.

The simplicity and low cost of the Daramend technology make it an extremely attractive alternative to other forms of treatment. In addition Grace Dearborn is one of the few companies marketing a biological treatment technology which has defensible scientific data to back up their claims.

Full Scale Cost Estmate: $70-85/m3

REFERENCES

Grace Dearborn Inc. 1994. Pilot Scale Demonstration of Daramend Enhanced Bioremediation of Sediment Contaminated With Polycyclic Aromatic Hydrocarbons, Hamilton Harbour, Ontario. Report to the Great Lakes Cleanup Fund, Environment Canada, Burlington, Ontario.

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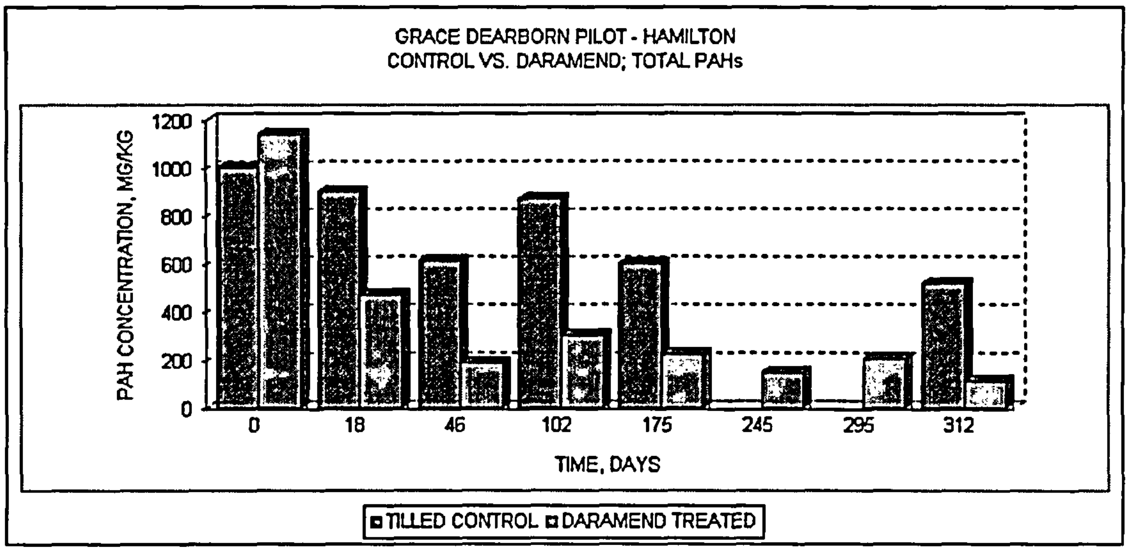

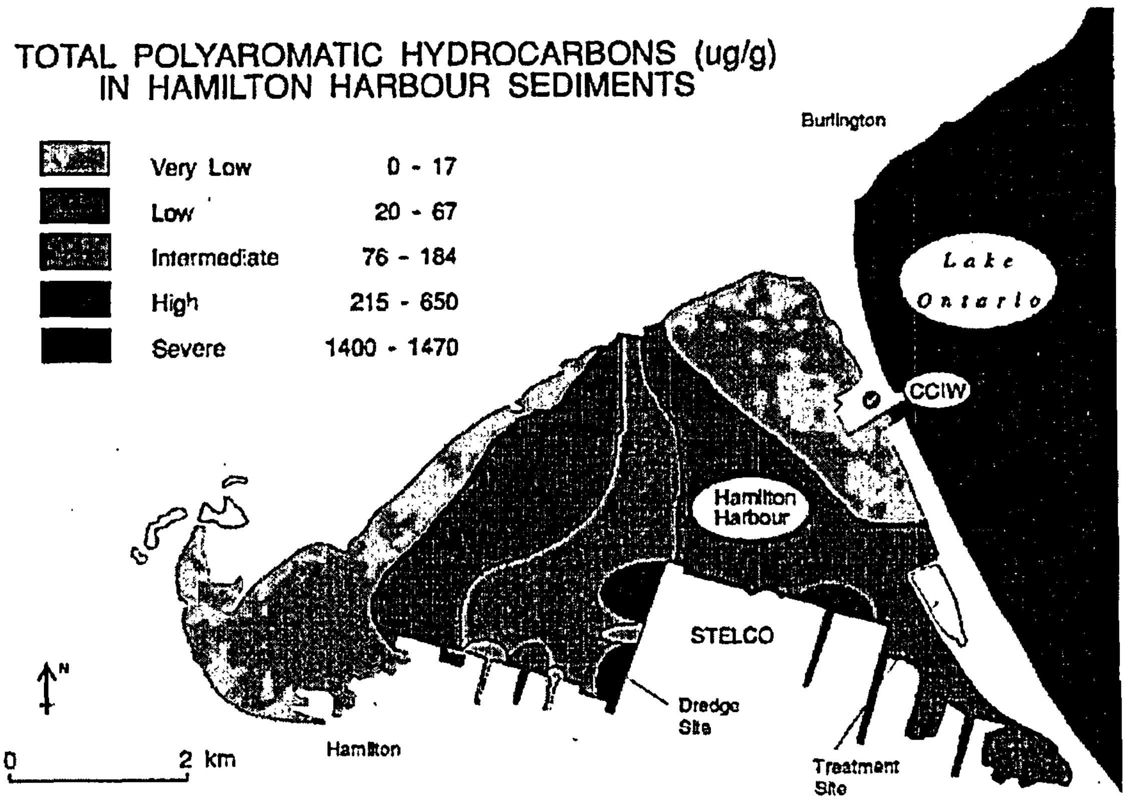

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Groundwater Technology, Ozone Sparging Process

30-Dec-97

Technology Type: Chemical TechID: 281

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, VOCs, Halogenated Organics, BTEX, Explosives, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Ozone is sparged directly into groundwater and soils in-situ, or is contacted with dry soils or slurries in constructed above-ground piles, tanks or bins. Ozone reacts with many organic contaminants directly or through the production of hydroxyl radicals, ultimately oxidizing them to carbon dioxide, water and chloride/nitrate/sulphate ions. Ozone sparging takes full advantage of the proven benefits of air sparging as an in-situ treatment method for impacted soils and groundwater. Whereas conventional sparging requires compounds to be either volatile/strippable and/or biodegradable to function, ozone sparging is effective against a broader range of contaminants. Ozone injection may be used to speed the remediation of volatile/strippable compounds, or as a pretreatment or post-treatment for biosparging.

Ozonation is particularly effective against substituted phenols and aromatic compounds, including PAH's, PCB's, dioxins/furans, chloro- and nitrophenols, BTEX etc. It is also effective against all compounds containing carbon-carbon double bonds, including PCE/TCE/DCE/VCM. With chemical amendments such as hydrogen peroxide, ozone sparging can be extended to treat a wide variety of compounds including ketones, ethers and sulfur/nitrogen-containing compounds of all kinds.

Ozone is generated on-site using standard methods, from either air or oxygen. Ozone is injected into sparging wells either alone or in combination with sparged air. Ozone breakthrough control, if required, is provided by a soil vapour extraction system fitted with an ozone-destruction catalyst.

This technology has been demonstrated by GTI in numerous on-site pilot tests and treatablility studies. At one site, groundwater concentrations of pentachlorophenol (PCP) were reduced in-situ by as much as 99.9% in six weeks. Bench-scale treatability testing and careful full-scale design are required for a successful installation.

Limitations: In-situ: The limitations of conventional air-sparging apply: sufficient vertical permeability in the subsurface and relative homogeneity of subsurface strata are required, and contamination must be at depths of less than about 200 feet. Compounds must also be reactive with ozone or hydroxyl radicals.
Ex-situ: Reactivity of the contaminants with ozone and the removal of flowing product materials is required. Sludges or soils with high organic contents may be costly to treat. Metals may be reduced in mobility but are not treated.
.....Compounds which are difficult to treat: saturated chlorinated compounds (DCA, TCA, DCM, CHI3, CCI4), Freons; acetone.

Efficiency Description:

Government Funding: DESRT, GASReP, SITE

Environmental Concerns: Proper handling for ozone, requires vent system, periodic sampling.

Health & Safety Plan Available: ☐

Regulatory Approvals Off-gas treatment may be required.

Setup/Feed: Setup Time (days): Breakdown Time (days):
Feed Rate Average (Tonne/hr): **0.00085**

Cost: Capital Cost (US$):
Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$20.00**

Operating cost: $210,000.00 assuming 10,000 tonnes.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Ozone - containing off-gas collected by vapour extraction system.

Developers:

Groundwater Technology Canada Ltd.
1500 Trinity Drive
Mississauga, ON
Canada L5T1L6

Contact: Martin, Paul
Phone: (905) 670-1700 Ext:
Fax: (905) 670-2009
Email:

Notes

Literature References:

Author: **Nelson, C., Braun, D.**
Title: Adapting Ozonation for Soil and Groundwater Treatment
Journal: Chemical Engineering Date: **Nov 1994**

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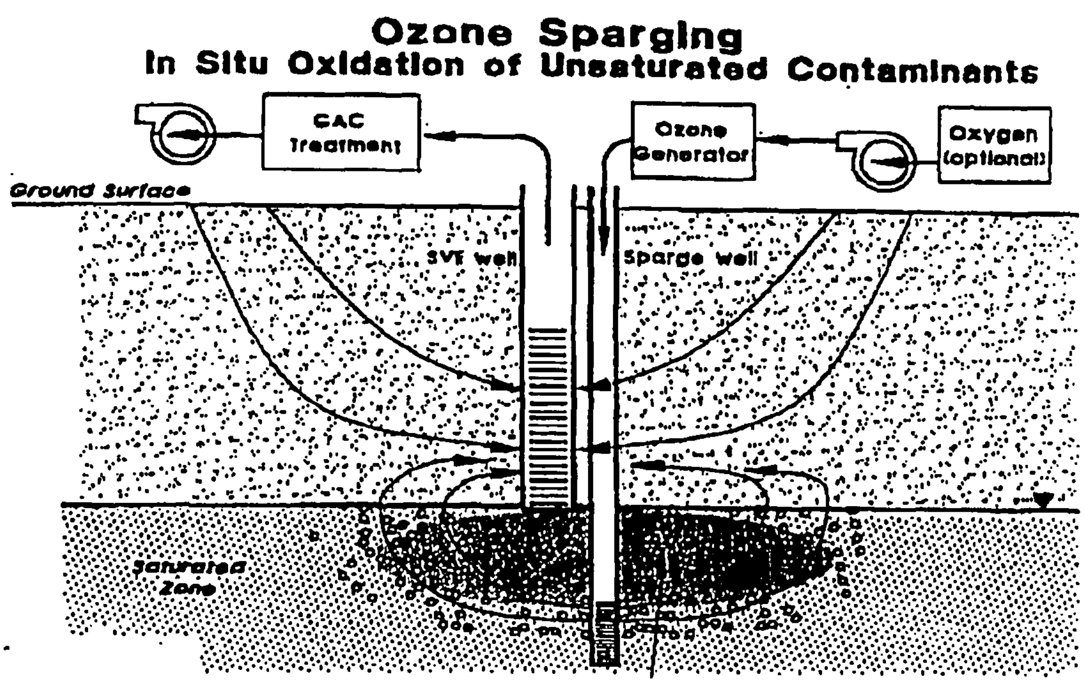
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.



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Groundwater Technology, Ozone Sparging Process

30-Dec-97

Project: Confidential **Year: 95**

Location: Florida Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Pentachlorophenol; tetrachlorophenol

Emissions/ByProducts:

Description: Pilot test of direct in-situ ozone sparging at a former wood-treating site. Removals of total chlorophenols in groundwater of as much as 99+% were observed in some locations, decreasing from the point of injection. Preliminary soil analysis shows significant PCP/TeCP reductions in saturated soils. Project duration: 6 weeks.

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Gulf Canada, Bioremediation

30-Dec-97

TechID: 93

Technology Type: Biological, Pre Treatment
Salt leaching, aggregation

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, BTEX
Brine salts

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

The Bio-Reactor Project has tested the utility of using bioremediation to treat three upstream oil field contaminated materials: crude oil contaminated topsoil, diesel invert drilling mud residues, and flare pit sludge. All wastes contained more than 4% hydrocarbons and excesses of formation salts. An experimental solid-state bioreactor was constructed and the three wastes were leached to remove salts and bioremediated for 1 to 3 years. During field treatment the value of soil aggregation, tillage, forced aeration, heating, bed depth and inoculation were evaluated - as well other factors such as fertilization - were tested under lab conditions. A second simple field unit (Bio-Pile) was constructed which simulated operational conditions and had provisions for heating and irrigation. Both the Bio-Reactor and the Bio-Pile could be operated twelve months of the year with minimum maintenance. Treatment progress was monitored by measuring hydrocarbon disappearance, soil respiration and ecotoxicity.

Results for all three materials showed that total hydrocarbons could be substantially reduced, but that a large pool of residuals would remain indefinitely (0.5-5% for years). However, toxicity was greatly reduced or eliminated and the residual hydrocarbons were stable and not bioavailable. The critical management options involved removal of salts, a large initial dose of nitrogen and a warm, moist environment. Other factors resulted in minor or no improvement on the bioremediation process efficiency or effectiveness.

Limitations: Bioremediation is relatively inexpensive but compared to other technologies, it requires a long treatment time. For nonrefined contaminants a large hydrocarbon residual persists which may limit disposal under current regulations.

Efficiency Description: 50-95%

Government Funding: DESRT, GASReP

Environmental Concerns: Final disposal

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne): **$40.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Gulf Canada Resources Ltd.
401-9th Ave. S.W.
Calgary, Alberta
Canada T2P 2H7

Contact: Callow, Lin
Phone: (403) 233-3924 Ext:
Fax: (403) 233-5449
Email:

Notes

Literature References:

Author: **Danielson, R.M., Johnson, R.L., Visser, S.**
Title: Five reports published by CAPP (403-267-1100), also newsletters
Journal: Reports to Canadian Association of Petroleum Producers Date: **Jan 1993**

Author: **Johnson, R.L., Visser, S.**
Title: Meetings
Journal: Proceedings GASReP & DESRT Date: **Jan 1993**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Gulf Canada, Bioremediation

30-Dec-97

Project: Bio-Reactor Project

Year: 91

Location: Nevis, Alberta, Canada

Pilot Scale

Client/Funding Agency	Contact	Phone
GASReP, DESRT, CAPP, AERT, PERD		

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 50

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Hydrocarbon solid waste

Contaminants Treated: Cleanup Goal: Biological Stability

Emissions/ByProducts:

Description:

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Haecon, BIO-C

06-Jan-98

Technology Type: Biological TechID: 327

Contaminants Treated: PAH's, PCB's, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX
Sulphides

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

This technology was formerly named ABR/CIS - Augmented Bio Reclamation/Conditioning In-Situ. BIO-C was developed by HAECON N.V., EMR B.V.B.A. and SYBRON Chemicals Inc.

BIO-C is a process of selecting aerobic bacteria for the degradation of specific contaminants. The microorganisms are extracted from the contaminated sediment, cultured with a contaminate substrate and returned to the sediment to accelerate the naturally occurring decontamination process. BIO-C is an in-situ treatment where natural aerobic microbiological activity is re-activated through the injection of a blended natural mineral product rich in bioavailable oxygen and nutrients.

BIO-C results in the cultured bacteria being provided with a suitable environment for degradation and the stimulation of all indigenous aerobic bacteria. The organic contaminants are biodegraded and a reduction in volume of the sediment deposit results.

Limitations:

Efficiency Description: Volume reduction of sediment in-situ (20%-50% in approx. 5 months)

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Accepted by Dutch WVO-legislation (protection surface waters)

Setup/Feed: Setup Time (days): 25 Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $34.00

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Water, carbon dioxide and methane

Developers:

HAECON N.V.
Deinsesteenweg 110
Ghent, Drongen
Belgium B-9031
Notes

Contact: Malherbe, B.
Phone: 32 9 226-5094 Ext:
Fax: 32 9 227-6105
Email:

Vendors:

HAECON N.V.
Deinsesteenweg 110
Ghent, Drongen
Belgium B-9031
Notes

Contact: Malherbe, B.
Phone: 32 9 226-5094 Ext:
Fax: 32 9 227-6105
Email:

Literature References:

Author: **Malherbe, B.**
Title: ABR-CIS (BIO-c) Bioremediation: Full Scale Experiences with an in-situ Treatment System for Sediment Release Reduction
Journal: and Contaminant ...
Date: Nov 1992

Author: **De Meyer, C., De Vos, K. Malherbe, B., Van der Zwan, W.**
Title: Experiences with in-situ BIO-C Bioremediation of Sediments in Harbour and Waterway
Journal: CATSII Congress on Characterization and Treatment of Sludge
Date: Nov 1993

Author: **De Meyer, C., Charlier, R.H., Malherbe, B.**
Title: In-Situ Microbiological Treatment of Sediments with BIO-C System
Journal: International J. of Environmental Studies (OPA)
Date: Jan 1995

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Haecon, BIO-C *06-Jan-98*

Project: Leie Project **Year: 95**
Location: Leie, Belgium Full Scale Demo

Client/Funding Agency	Contact	Phone
Ministry of the Flemish Community		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated voume of sediments: 9000 m³

Project: VMM Pond Project **Year: 94**
Location: Erembodegem, Belgium Full Scale Demo

Client/Funding Agency	Contact	Phone
Vlaamse Milieu Maatschappij (VMM)		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated volume of sediments: 200 m³

Project: De Bild Arenberg Project **Year: 94**
Location: De Bild Arenberg, Netherlands Full Scale Demo

Client/Funding Agency	Contact	Phone
Consulmij b.v.		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated volume of sediments: 2000 m³

Project: Zierikzee Project **Year: 93**
Location: Zierikzee, Netherlands Full Scale Demo

Client/Funding Agency	Contact	Phone
Ministry of Economical Affairs, Netherlands		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:

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Description: Treated volume of sediments: 1000 m³

Project: Moervaart Project — **Year: 93**
Location: Moervaart, Belgium — Full Scale Demo

Client/Funding Agency	Contact	Phone
Ministry of the Flemish Community		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated volume of sediments: 20,000 m³

Project: Aperldoornkanaal Project — **Year: 92**
Location: Aperldoornkanaal, Netherlands — Full Scale Demo

Client/Funding Agency	Contact	Phone
RIZA		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated volume of sediments: 140 m³

Project: Kamerikse Wetering Project — **Year: 92**
Location: Kamerikse Wetering, Netherland — Full Scale Demo

Client/Funding Agency	Contact	Phone
RIZA		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:
Description: Treated volume of sediments: 140 m³

Project: Oude Tonge Project — **Year: 92**
Location: Oude Tonge, Netherlands — Full Scale Demo

Client/Funding Agency	Contact	Phone
Cosulmij B.V.		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):
Treatment Cost (US$):
Setup Time (days): Breakdown Time (days):
Media Treated:
Contaminants Treated:
Emissions/ByProducts:

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Emissions/ByProducts:

Description: Treated volume of sediments: 620 m³

Project: Krimpenerwaard Project **Year: 91**

Location: Krimpenewaard, Netherlands Full Scale Demo

Client/Funding Agency	Contact	Phone
Waterschap Meer en Woude		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treated volume of sediments: 160 m³

Project: Zoeterwoude Project **Year: 91**

Location: Zoeterwoude, Netherlands Full Scale Demo

Client/Funding Agency	Contact	Phone
Waterschap Meer en Woude		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treated volume of sediments: 1000 m³

Project: Zeebrugge Project **Year: 90**

Location: Zeebrugge, Belgium Full Scale Demo

Client/Funding Agency	Contact	Phone
Ministry of Public Works, Belgium		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treated volume of sediments: 1000 m³

Project: Edegem Project **Year: 90**

Location: Edegem, Belgium Full Scale Demo

Client/Funding Agency	Contact	Phone
Tabacofina		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

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Emissions/ByProducts:

Description: Accidental discharge of Heavy Fuel. Treated volume of sediments: 65 m^3

Project: Bakhuistervaart Project **Year: 90**

Location: Bakhuistervaart, Netherlands

Full Scale Demo

Client/Funding Agency	Contact	Phone
Municipality of Gaasterlan - Sleat - Friesland		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description: Treated volume of sediments: 1730 m^3

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Heidemij Cum-Bac

06-Jan-98

TechID: 50

Technology Type: Biological

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

Based on the technology of landfarming, Cum-Bac is an enclosed system for the bioremediation of soils. Temperature, moisture and aeration can all be controlled for optimal conditions and thus the duration and rate of biodegradation can be increased. In most cases only 6 to 9 months (one season) is required for desired results.

The set-up includes a greenhouse-like structure with a leak-proof bottom, water pumps and aeration tubes.

The cleaned soils can be used in gardens and parks.

Limitations:

Efficiency Description: Up to 95%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 20 Breakdown Time (days): 10

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $40.00 – $55.00 Average Cost (US$/Tonne): $47.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Under investigation

Developers:

Heidemij
1, Lovinklaan, P.O. Box 33
Arnhem, LE
The Netherlands 6800 -
Notes

Contact:
Phone: 31 85 778911 Ext:
Fax: 31 85 515235
Email:

Vendors:

IHC Dredge Technology Corporation
P.O.Box 1520, 148 Oakwood Dr.
Wayne, N.J.
USA 07474-1520
Notes

Contact: Ouwerkerk, R.
Phone: (201) 696-1559 Ext:
Fax: (201) 696-3572
Email:

Literature References:

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Heidemij/IHC Froth Flotation

06-Jan-98

Technology Type: Pre Treatment — TechID: 103

Contaminants Treated: PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

Froth flotation is an application of surfactant extraction. Using water and "special soaps" the pollutants are isolated from both water and soil particles. Air is then bubbled through the mixture for the pollutants to cling to. The air bubbles rise to form a foam on top which can be easily scooped off. The water and soil fractions are separated. The water undergoes further cleaning before reuse.

This mobile on site treatment reduces the amount of waste material to be treated to 1-15% of the original polluted soil. Therefore, transportation and further treatment costs are greatly reduced.

This process is suitable for oil products, organo-chlorine compounds, PAH's, cyanide compounds, heavy metals and arsenic compounds.

Other pre-treatment technologies that are employed include sieve belt presses, decanter centrifuges, filter presses and settling tanks, all for dewatering, and hydrocyclones, vibrating sieves and influent buffers for separation and classification.

Limitations:

Efficiency Description: 60%-98% treatment efficiency

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 10 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 4

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $150.00 – $190.00 Average Cost (US$/Tonne): $170.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleaned soil, recyclable water, concentrated contaminant froth

Developers:

Heidemij
1, Lovinklaan, P.O. Box 33
Arnhem, LE
The Netherlands 6800 -
Notes

Contact:
Phone: 31 85 778911 Ext:
Fax: 31 85 515235
Email:

Vendors:

IHC Dredge Technology Corporation
P.O.Box 1520, 148 Oakwood Dr.
Wayne, N.J.
USA 07474-1520
Notes

Contact: Ouwerkerk, R.
Phone: (201) 696-1559 Ext:
Fax: (201) 696-3572
Email:

Literature References:

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Hepaco Inc., Bioremediation

06-Jan-98

TechID: 184

Technology Type: Biological

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, BTEX

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

HEPACO offers cost-effective solutions for soil contamination, using both long-established standard methods and state-of-the-art technologies. The work is performed by trained HEPACO personnel in accordance with our standard operating procedures, which comply with regulatory requirements and ensure safe working conditions throughout soil excavation, transportation, soil staging, analytical testing, on-site treatment, and disposal.

HEPACO is proficient in excavating and handling hazardous and non-hazardous soils, sludges, and debris. These operations include provision of associated construction control measures, such as properly contained staging areas, haul roads, stormwater and groundwater control, and excavation bracing. We routinely manage off-site disposal of hazardous contaminated soils when regulations, costs, or other considerations dictate this to be the preferred alternative. HEPACO also has substantial experience in cost-effective on-site treatment of contaminated soils, including:

* Stabilization/Fixation
* Bioremediation
* Thermal Treatment
* Landfarming
* Soil Venting

The objective of on-site soil treatment is to reduce contamination such that the soil can be used as fill on site or disposed of off site as nonhazardous material. HEPACO designs a practical approach using the appropriate technology and implements the plan, using either our own skilled staff and equipment or selected expert specialty contractors under HEPACO direction and management.

Limitations:

Efficiency Description: 97%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Numerous site specific EPA, state, and county approvals.

Setup/Feed: Setup Time (days): 2 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 200

Cost: Capital Cost (US$): $170,000.00

Treatment Cost (US$/Tonne): $25.00 – $45.00 Average Cost (US$/Tonne): $35.00

Assuming 10,000 tonnes and Petroleum contamination.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Negligible emissions or volatilization.

Developers:

HEPACO Inc.
4745 Hugh Howell Rd.
Tucker, GA
USA 30084-
Notes

Contact: Anderson, Neville
Phone: (770) 934-1180 Ext:
Fax: (770) 621-0238
Email:

Vendors:

HEPACO Inc.
4745 Hugh Howell Rd.
Tucker, GA
USA 30084-
Notes

Contact: Anderson, Neville
Phone: (770) 934-1180 Ext:
Fax: (770) 621-0238
Email:

Literature References:

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Hepaco Inc., Bioremediation

06-Jan-98

Project: Charlotte Mecklenburg Airport

Location: Charlotte, NC, USA

Year: 92

Full Scale Demo

Client/Funding Agency	Contact	Phone
City of Charlotte		

Not Audited

Feed Rate (Tonne/hr): 100
Amount Treated (Tonne): 34000

Treatment Cost (US$):

Setup Time (days): 2
Breakdown Time (days): 2

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:
TPH	2,000 ug/g	100 ug/g	95
BTEX			

Leachate test method: TPH
Cleanup Goals: Action levels were less than 100.

Emissions/ByProducts: Negligible net loss due to volatilization.

Description: HEPACO performed an ex-situ bioremediation process. The contaminated soil was excavated, mixed with nutrients, and staged in continous stockpiles. The soils indigenous bacteria was encouraged to proliferate and feed on the contaminant.

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Hepaco Inc., Soil Fixation/Stabilization

06-Jan-98

Technology Type: Stabilization/Fixation TechID: 350

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, BTEX

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

HEPACO offers cost-effective solutions for soil contamination, using both long-established standard methods and state-of-the-art technologies. The work is performed by trained HEPACO personnel in accordance with our standard operating procedures, which comply with regulatory requirements and ensure safe working conditions throughout soil excavation, transportation, soil staging, analytical testing, on-site treatment, and disposal.

HEPACO is proficient in excavating and handling hazardous and non-hazardous soils, sludges, and debris. These operations include provision of associated construction control measures, such as properly contained staging areas, haul roads, stormwater and groundwater control, and excavation bracing. We routinely manage off-site disposal of hazardous contaminated soils when regulations, costs, or other considerations dictate this to be the preferred alternative. HEPACO also has substantial experience in cost-effective on-site treatment of contaminated soils, including:

* Stabilization/Fixation
* Bioremediation
* Thermal Treatment
* Landfarming
* Soil Venting

The objective of on-site soil treatment is to reduce contamination such that the soil can be used as fill on site or disposed of off site as nonhazardous material. HEPACO designs a practical approach using the appropriate technology and implements the plan, using either our own skilled staff and equipment or selected expert specialty contractors under HEPACO direction and management.

Limitations:

Efficiency Description: 98%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Numerous site specific EPA, state, and County approvals.

Setup/Feed: Setup Time (days): 2 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 200

Cost: Capital Cost (US$): $170,000.00

Treatment Cost (US$/Tonne): $35.00 – $80.00 Average Cost (US$/Tonne): $58.00

Assuming 10,000 tonnes and contamination from batteries.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Negligible emissions or volatilization.

Developers:

HEPACO Inc.
4745 Hugh Howell Rd.
Tucker, GA
USA 30084-
Notes

Contact: Anderson, Neville
Phone: (770) 934-1180 Ext:
Fax: (770) 621-0238
Email:

Vendors:

HEPACO Inc.
4745 Hugh Howell Rd.
Tucker, GA
USA 30084-
Notes

Contact: Anderson, Neville
Phone: (770) 934-1180 Ext:
Fax: (770) 621-0238
Email:

Literature References:

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Hepaco Inc., Soil Fixation/Stabilization

06-Jan-98

Project: TREC/MCA **Year: 95**

Location: Atlanta, GA, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
TREC	Gary Marsh	(404) 931-4433

Not Audited

Feed Rate (Tonne/hr): 70 Amount Treated (Tonne): 800

Treatment Cost (US$): $68,000.00

Setup Time (days): 2 Breakdown Time (days): 2

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:	Untr. leach.	Tr. Leach.
Lead	200 ppm	2-4 ppm	98	200 ppm	2-4 ppm
Cadmium	100 ppm	.5 ppm	99	10 ppm	.5 ppm

Clean-up Goals: The Federal and state clean-up level was less than 5 ppm.

Emissions/ByProducts:

Description: HEPACO performed an ex-situ soil fixation treatment to reduce the heavy metal content in the soils. The excavated soil was mixed with a fixation reagent and allowed to cure, after which they were sampled by an independent third party. Treatment cost: $85.00 ton.

Project: Willard Industries/Soil Fixation **Year: 94**

Location: Charlotte, NC, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 310

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Soil

Contaminants Treated:

	Untreated:
Lead	100,000 mg/kg

Emissions/ByProducts:

Description: HEPACO was contracted by the client to provide treatment and disposal services for 310 tonnes of lead-impacted soils. These soils were located in a ditch extending over 100 m long on a Willard facility property line. Hepaco's approach to the project involved performing an in-situ treatment of the lead impacted soil. The extent of the contamination was only superficial thus, making in-situ treatment feasible and the more cost-effective remedial approach. Hepaco renderd the lead-impacted soils non-hazardous by RCRA definition for characterisitc waste utilizing a chemical treatment process. The original total lead concentrations were as high as 100,000 mg/kg and TCLP lead as high as 360 mg/kg. The treatment of the lead-impacted soil was performed on-site by introducing liquid chemicals directly onto the soils, and then mixing with the top 15 cm of soil until homogenous. A mobile laboratory was situated on the site to provide immediate confirmation analysis. The confirmation analysis included both TCLP and total lead analysis. The validity of the field analysis was then confirmed by shipping quality control samples to a local laboratory for analysis. The results of these samples confirmed the success of the treatment process. Confirmation soil samples were taken every 50-100 tonnes and tested for total and TCLP lead by an on-site mobile laboratory. After the soil was rendered non-hazardous, the soil was transported to a subtitle D landfill for disposal.

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Horsehead Resource Development Co. Inc., HRD Flame Reactor

06-Jan-98

TechID: 87

Technology Type: Thermal

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Halogenated Organics

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☐

Description:

The Horsehead Resource Development Co. Inc. (HRD), flame reactor is a patented, hydrocarbon-fueled, flash-smelting system that treats residues and wastes contaminated with metals. The reactor processes wastes with hot (greater than 2,000 degrees Celcius) reducing gases produced by combusting solid or gaseous hydrocarbon fuels in oxygen-enriched air. In a compact, low-capital cost reactor, the feed materials react rapidly, allowing a high waste throughput. The end products are a non-leachable, glass-like slag; a potentially recyclable, heavy metal-enriched oxide; and in some cases, a metal alloy. The volatile metals are fumed and captured in a product dust collection system; nonvolatile metals partition to the slag or may be separated as a molten alloy. Organic compounds are destroyed at the elevated temperature of the flame reactor technology. Volume reduction (of waste to slag plus oxide) depends on the chemical and physical properties of the waste.

In general, the system requires that wastes be dry enough (less than 5 percent total moisture) to be pneumatically-fed, and fine enough (less than 200 mesh) to react rapidly. Larger particles (up to 20 mesh) can be processed; however, the efficiency of metals recovery is decreased. The test facility has a capacity of up to 3 tonnes per hour. Individual units can be scaled to a capacity of 7 tonnes per hour.

Limitations: Waste must be fine, free-flowing solid, generally < 5 % moisture.

Efficiency Description: 90%

Government Funding: SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.4

Cost: Capital Cost (US$): $9,000,000.

Treatment Cost (US$/Tonne): $250.00 – $300.00 Average Cost (US$/Tonne): $275.00

Assuming 10,000 tonnes.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Meets air quality requirements, no water discharge.

Developers:

Horsehead Resource Development Co., Inc.
300 Frankfort Road
Monaca, PA
USA 15061-
Notes

Contact: Zagrocki, Regis
Phone: (412) 773-2289 Ext:
Fax: (412) 773-2273
Email:

Vendors:

Horsehead Resource Development Co., Inc.
300 Frankfort Road
Monaca, PA
USA 15061-
Notes

Contact: Zagrocki, Regis
Phone: (412) 773-2289 Ext:
Fax: (412) 773-2273
Email:

Literature References:

Author: **Bounds, C.O., Pusateri, J.F.**
Title: EAF Dust Processing in the Gas-Fired Flame Reactor Process
Journal: TMS-AIME, Lead-Zinc-Tin '90 World Symposium Date: Feb 1990

Author: **Zagrocki, R.J.**
Title: High Temperature Metal Recovery of Lead from Hazardous Wastes
Journal: SME-AIME Annual Meeting Date: Feb 1992

Author: **Zagrocki, R.J., Pusateri, J.F.**
Title: The HRD Flame Reactor Process for the Treatment of Contaminated Soils
Journal: Air & Waste Management Association 85th Meeting Date: Jun 1992

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Horsehead Resource Development Co. Inc., HRD Flame Reactor

06-Jan-98

Author:

Title: Horsehead Resource Development Co., Inc. (Flame Reactor)

Journal: SITE Technology Profile

Date: Nov 1994

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Horsehead Resource Development Co. Inc., HRD Flame Reactor

06-Jan-98

Project: Superfund Site — **Year: 91**

Location: Atlanta, GA, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA	Donald Oberacker	(513) 569-7510

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 72

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Slag

Contaminants Treated:

	Untreated:	Treated:
Arsenic	428-1040 mg/kg	92.1-1340 mg/kg
Cadmium	356-512 mg/kg	2.3-13.5 mg/kg
Copper	1460-2590 mg/kg	2730-3890 mg/kg
Iron	95,600-130,000 mg/kg	167,000-228,000 mg/kg
Lead	48,200-61,700 mg/kg	1,560-11,400 mg/kg
Zinc	3,210-6,810 mg/kg	711-1,680 mg/kg

Emissions/ByProducts:

Description: The major objectives of the SITE technology demonstration were to investigate the reuse potential of the recovered metal oxides, evaluate the levels of contaminants in the residual slag and their leaching potential, and determine the efficiency and economics of processing. The SITE demonstration was conducted on secondary lead smelter-soda slag from the National Smelting and Refining Company (NSR) Superfund site in Atlanta, GA, USA.

Project: C & R Battery Co., Inc. — **Year: 91**

Location: Richmond, Virginia, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Versar, Inc.	Andrew Oravetz	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 5

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Slag

Contaminants Treated:

Contaminants	Untreated:	Treated:
Lead	8900 ug/g	

Emissions/ByProducts:

Description:

Project: National Smelting and Refining Co. — **Year: 91**

Location: Atlanta, Georgia, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA - RREL	Donald Oberacker	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 72

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Slag

Contaminants Treated:

Contaminants	Untreated:	Treated:
Lead	48200 ug/g	11400 ug/g
Cadmium	356 ug/g	13.5 ug/g

Emissions/ByProducts:

Description:

Project: Non-Ferrous Metal Industry — **Year: 89**

Location: ,, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

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Horsehead Resource Development Co. Inc., HRD Flame Reactor

06-Jan-98

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 100

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Contaminants	Untreated:	Treated:
Lead		
Cadmium		

Emissions/ByProducts:

Description:

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Hrubetz Environmental Services Inc., Hrubout (tm) *06-Jan-98*

Technology Type: Thermal TechID: 67

Contaminants Treated: Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The HRUBOUT process is capable of treating a broad variety of organic halogenated or nonhalogenated volatiles, as well as semivolatiles, at any concentration range, which includes but is not limited to solvents, gasoline, jet fuel, diesel, crude oil, lube oils, and creosotes. The technology allows for application to all types of soils from sand to clay.

The equipment is very versatile, mobile, and relatively compact. The unit requires electricity which can be supplied by either a generator or a three-phase power hook-up to an existing power source. The burner and oxidizer are fueled by either natural gas or propane. The units can operate twenty-four hours a day, are completely weatherproofed, and require minimal manpower. VOC destruction rate is a minimum of 99.5 percent.

There are no waste streams produced, eliminating the need for further treatment. The process eliminates the need to landfill soils, and therefore reduces potential future liability. The technology can be applied in situ or on excavated soils. It provides good economics and enhances remedial treatment time.

The HRUBOUT process (U.S. Patent No. 5,011,329) is a mobile thermal treatment batch process that removes volatile and semivolatile organic compounds from contaminated soils. In the in-situ process, heated air is injected into the soil below the zone of contamination, evaporating the soil moisture and removing the VOCs and SVOCs. Once the water is evaporated, the soil porosity and permeability is increased, allowing for increases in pressure and temperature. Low-volatility hydrocarbons can then be removed by slow oxidation at higher temperatures.

HRUBOUT is available in three embodiments: in situ, ex situ and a containerized version. In the in situ method, injection wells are drilled in pre-determined distribution patterns to a depth below the contaminated zone. The wells are equipped with steel casing, perforated at the base and cemented in the hole. Heated, compressed air is introduced at temperatures up to 1,200 degrees Fahrenheit and pressure is slowly increased. As the vapors reach the surface, which is covered with an impermeable cover, a vacuum directs the vent gases to an oxidizer, where they are destroyed at 1,500 degrees Fahrenheit with a 0.6-second retention time. Larger areas can be remediated sequentially until the entire area has been treated.

The ex situ soil-pile process involves a horizontal piping grid overlain with a mound of soil and remediates approximately 1,100 cubic yards per batch. The mound is covered with an impermeable membrane and is treated in the same manner with heated, compressed air.

The containerized method remediates approximately 25 cubic yards per batch and is processed similarly, except that the soil is enclosed in an insulated container. It is especially adaptable for use at refineries or processing plants that yield daily quantities of contaminated soils or sludges as a by-product. The excavated soils allow for faster processing of each batch as excavation allows for greater permeability. The in situ process treats a specific unit area, and for large areas is moved sequentially over the surface until the entire area has been treated.

The process is capable of treating a wide range of hydrocarbons in various soils. It eliminates the need to excavate, transport and landfill soils. There is no residual waste.

Early research and development led to the development of the first prototype commercial unit in August, 1990. The unit was subjected to nearly three months of continuous operation at a test site. Results confirmed bench tests which indicated that soil could be heated to temperatures that would volatilize -- and in the case of the more inert hydrocarbons, oxidize -- common hydrocarbon-derived contaminants. Field tests of vacuum injection methods and operating techniques have continued to the present date.

On April 30, 1991, U. S. Patent No. 5,011,329 was issued covering the process. Subsequent U.S. Patent Nos. 5,251,700 ; 5,261,765 and 5,325,795 covers the soil pile and container processes.

The process was approved by the Texas Water Commission in December, 1991. For nonhazardous wastes in Texas, only a Standard Exemption 68 is required from the Texas Air Control Board for air emissions. Also approved by the Ministry of Environment, Ontario, Canada.

Limitations: A shallow water table inhibits the in-situ process for soil remediation. In this instance, sparging treatment would be employed, or the water table lowered by pumping.

Efficiency Description:

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Texas Natural Resources Conservation Commission and the Ministry of Environment, Ontario, Canada.

Setup/Feed: Setup Time (days): 2 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 25

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Hrubetz Environmental Services Inc., Hrubout (tm)

06-Jan-98

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$30.00 – $30.00** Average Cost (US$/Tonne): **$30.00**

Assuming total amount treated > 1000 tons; soil pile method; batch process. We can reduce costs if client provides fuel, electricity, or labor. We also sell or lease equipment in addition to providing full remediation services.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean solids, incinerator off-gases

Developers:

Hrubetz Environmental Services Inc.
5949 Sherry Lane, Suite 525
Dallas, TX
USA 75225-
Notes

Contact: Hrubetz, Barbara
Phone: (214) 363-7833 Ext:
Fax: (214) 691-8545
Email: PSWW68C@PRODI

Vendors:

Hrubetz Environmental Services Inc.
5949 Sherry Lane, Suite 525
Dallas, TX
USA 75225-
Notes

Contact: Hrubetz, Barbara
Phone: (214) 363-7833 Ext:
Fax: (214) 691-8545
Email: PSWW68C@PRODI

Literature References:

Author: **Davis, L.A., Miranda, J.E.**
Title: Texaco Hazardous Waste Gasification
Journal: The Environmental Professional, Vol. 12, pp. 40-44. Date: **Jan 1990**

Author: **Nelson, Joseph M.**
Title: In-Situ Soil Decontamination Method & Apparatus
Journal: U.S. Patent No. 5,011,329 Date: **Apr 1991**

Author: **Nelson, J.M.**
Title: Removal of Hydrocarbons from Soil with Heated Air
Journal: Electric Power Research Institute 1991 PCB Seminar, Baltimore, MD Date: **Oct 1991**

Author:
Title: Here's how it Works: HRUBOUT Hot Air Extraction Process
Journal: "Soils" Magazine Date: **Jan 1992**

Author: **Hrubetz, M., Hrubetz, B.**
Title: New Technology for In-Situ/Ex-Situ Soil Remediation
Journal: 3rd Annual Environmental and Safety Conference for the Oil, Gas, and Petrochemical Industries (PETRO-SAFE '92) Date: **Jan 1992**

Author: **Hrubetz, M., Hrubetz, B.**
Title: Soil Remediation Process Uses Hot Air
Journal: The American Oil and Gas Reporter Date: **Mar 1992**

Author: **US EPA**
Title: Superfund Innovative Technology Evaluation Program & Technology Profiles
Journal: Date: **Nov 1993**

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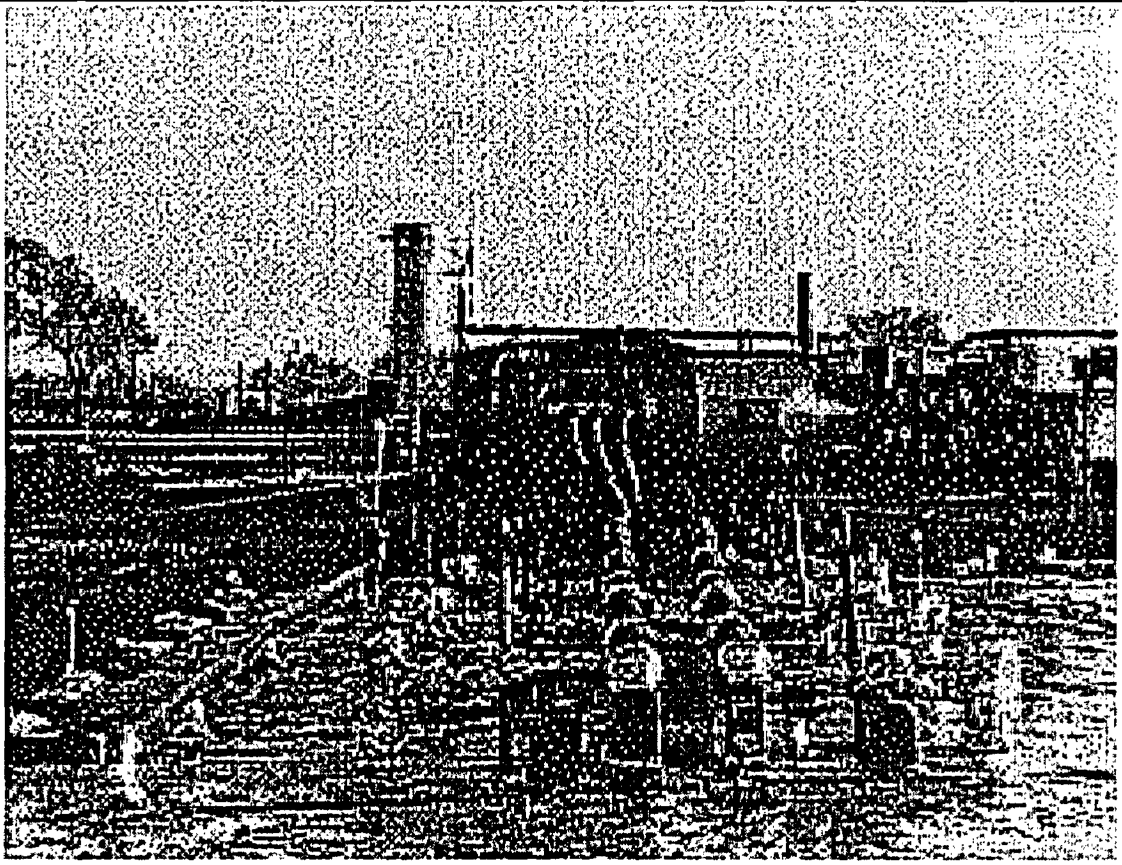
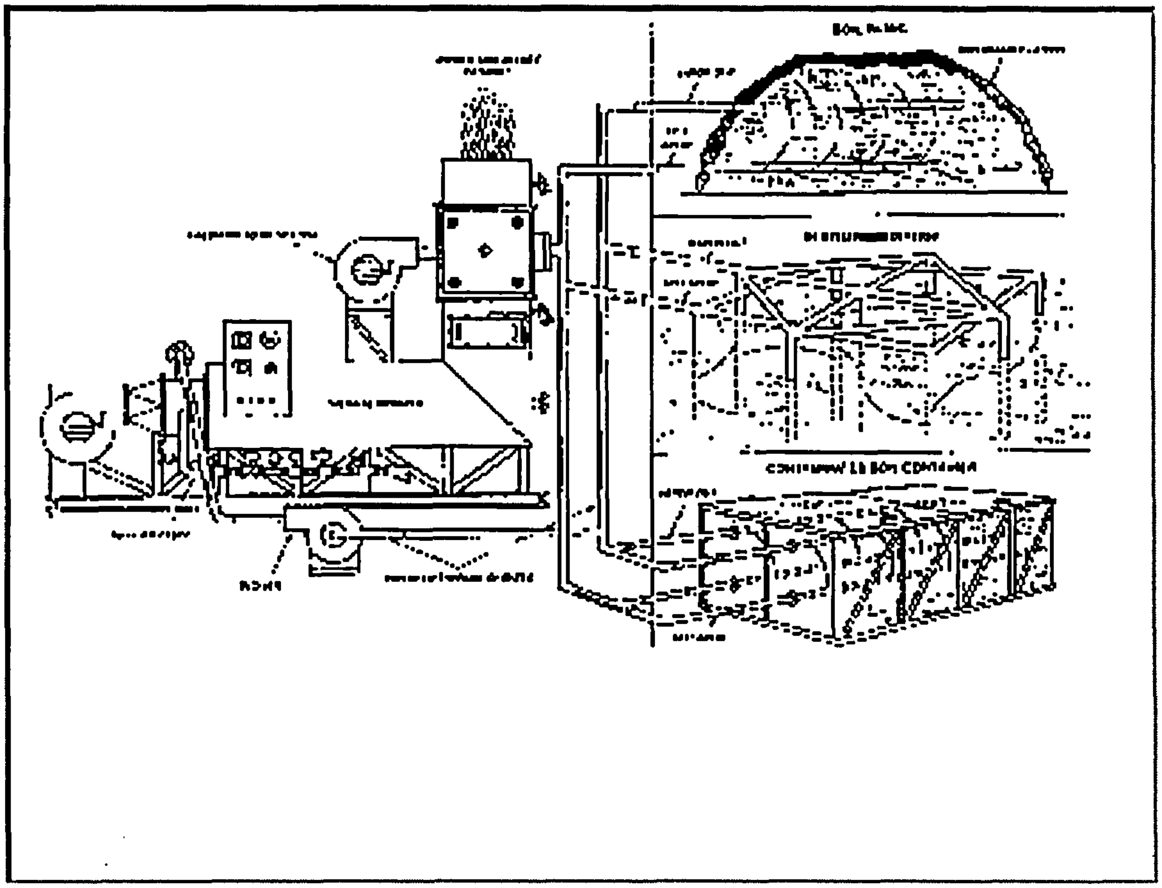
Hrubetz Environmental Services Inc., Hrubout (tm)

06-Jan-98





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Hrubetz Environmental Services Inc., Hrubout (tm)

06-Jan-98

Project: Richmond Hill (Toronto) **Year: 94**

Location: Toronto, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
La Farge Construction Co.	Dan Forsyth	(519) 699-5810

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Gasoline and Diesel

Emissions/ByProducts:

Description: Ex-situ pile method. The entire soil pile was set over a pipe grid approx. 70' x 90' and covered with a bigh-temp. tarp. Because the location was in a populated area, operations were not allowed at night or on weekends. Because of these restrictions, our unit ran only 175 cumulative hours.

Project: Orlando Project **Year: 94**

Location: Orlando, Florida, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Toluene

Emissions/ByProducts:

Description: Soil pile method. Amount treated: 100 tonnes. Treatment cost: $14,425.

Project: Kelly Air Force Base **Year: 93**

Location: San Antonio, Texas, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Risk Reduction Engineering Laboratory	U.S. EPA	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Jet Fuel

Emissions/ByProducts:

Description: EPA SITE Demonstration. 12,766 pounds of hydrocarbons (jet fuel) and 325,000 pounds of water was removed from the soil in the 16 days allocated to the project.

Project: Canadian Forces Base **Year: 93**

Location: Ottawa, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
Wing Construction Engineering, Ottawa, Ontario	Mike Pellerin, Contract Inspector	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

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Contaminants Treated: Jet Fuel

Emissions/ByProducts:

Description: Clean-up goal: 400 ppm. Untreated level: 21,000 ppm.

Project: Snyder, Texas Oilfield Cleaning Area **Year: 93**

Location: Snyder, Texas, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
Watson Parker Co., 11420 W. Hwy 80, Midland, TX	David Cockrell	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Varsol/Diesel

Emissions/ByProducts:

Description: Our 25 yard ^{3} portable container was used for this project. Electricity and fuel provided by client.

Project: South Texas Petrochemical Plant **Year: 92**

Location: South Texas Gulf Coast, Texas Full Scale Demo

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Diesel residue from plant's fire training.

Emissions/ByProducts:

Description: Portable 25 yard ^{3} container transported to site. Fuel and electricity furnished by client at site. Work was done for client on a confidential basis.

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HSM Ghea Extraction

06-Jan-98

TechID: 01

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The Ghea process utilizes a variety of extraction technologies on a wide range of contaminants and media. Surfactants are used for the primary extraction of contaminants from the soil. Following this is a cycle of filtrations and separations which leave the soil and water clean, fully recover the surfactants for reuse in the process, and concentrate the contaminants for disposal or reclamation, depending on composition.

A pilot plant for organics decontamination is under construction with designs for a continuous-flow system of skid mounted modules. Development and research continue at bench and pilot scale levels.

Limitations:

Efficiency Description: Benchscale : 99% of organics, 65%-85% some metals

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$50.00 – $80.00** Average Cost (US$/Tonne): **$65.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleaned soil and water, toxic or non-toxic concentrated contaminants

Developers:

Hazardous Substances & Materials Research Centre
161 Warren Street
Newark, NJ
USA 07102-
Notes

Contact: Gotlieb, I.
Phone: (201) 596-5862 Ext:
Fax: (201) 802-1946
Email:

Literature References:

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HTM Global Corporation, Soil Micronization/Air Stipping Process

06-Jan-98

TechID: 309

Technology Type: Stabilization/Fixation, Organic Extraction, Soil Washing/Volume Reduction
Non-Thermal Desorption

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Mercury, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

HTM's process is fast, environmentally sound and extremely cost efficient. It does not rely on expensive and inefficient thermal volatizing, nor does it involve lengthy time frames.

The SR-50 operates efficiently and quickly: Soil in need of treatment is loaded in the feed hopper, weighed and transferred to a helical mixer/conveyor where partial dewatering will take place. The material is then fed into the proprietary air stripping mill where it is immediately broken down to micronic size. This causes volatiles to be separated from the soil particles, homogenized and oxidized before entering the final filtering system. As the soil is air stripped of all volatiles it is separated from the oxidized air/volatiles mixture by a cyclone system. It is then discharged from the process and ready to return to its original place clean, where five minutes earlier it was excavated as "contaminated soil". The pulverized soil can be stabilized, or be used as a new construction material. The micronization process has applications for extraction in the mining industry.

It takes les than three hours to set up the equipment at a work site and begin remediation. Foreign materials such as stones, asphalt, wood or even granite, will not harm the equipment in any way.

Overall site requirements: 1,000 m² of level surface required for set-up and operation.

The remediated SEDIMENT by HTM-SR-50 can be stabilized or used directly for many beneficial uses such as shore protection, wet land creation, construction uses, etc.

Limitations: Moisture content >30%; non-volatile organics.

Efficiency Description:

Government Funding:

Environmental Concerns: No adverse effects on the soil's basic structure.

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 1 Breakdown Time (days): 1

Feed Rate Average (Tonne/hr): 4

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $20.00

Sediment is dewatered to approximately 25% moisture content. Mobilization/Demobilization within 500 km. Contaminant: Hydrocarbons. Initial level: 20,000 (ug/g dry). Final level: 500 (ug/g dry). Total amount treated: 10,000 tonnes.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

HTM Global Corporation
P.O.B. 130
Mildmay, Ontario
Canada N0G2J0
Notes

Contact: Talbot, John
Phone: (519) 367-5299 Ext:
Fax: (519) 367-4455
Email:

Vendors:

HTM Global Corporation
P.O.B. 130
Mildmay, Ontario
Canada N0G2J0
Notes

Contact: Talbot, John
Phone: (519) 367-5299 Ext:
Fax: (519) 367-4455
Email:

Literature References:

Author: **Shiralian, M.**

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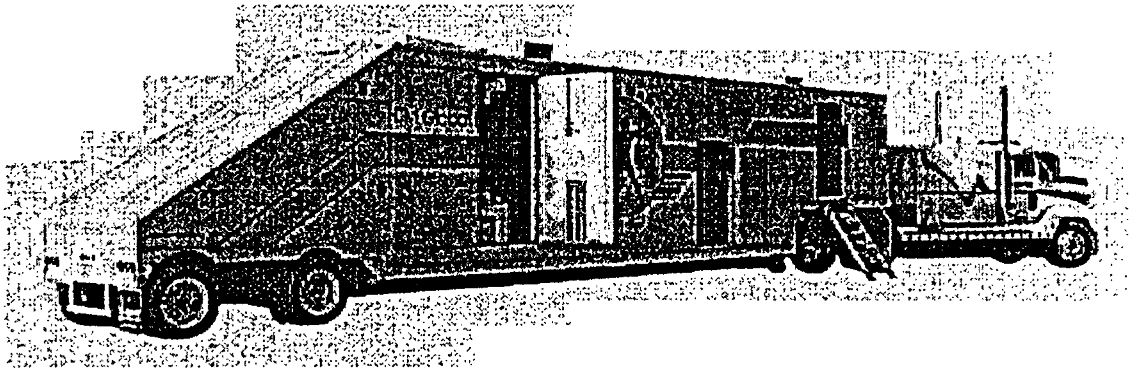
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Title: New Soil Remediation Technology, HTM SR-50 Process
Journal: Proceedings: Environment Canada, 5th Symposium of Soil/Groundwater Remediation Date: Sep 1995

Author: Shiralian, M.
Title: New Soil Remediation Technology, HTM SR-50 Process
Journal: Proceedings: Ontario Ministry of the Environment and Energy, Environment and Energy Conference Date: Nov 1995



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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Hygrex-Spehr Waste Reduction System

06-Jan-98

Technology Type: Post Treatment, Pre Treatment — TechID: 99

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☐

Description:

Very low humidity air is passed through the wet sediment picking up moisture due to differential vapour pressure. This vapour is condensed out as it passes over a chiller system. The new dry air is gently warmed via a heat exchanger before returning to the sediment container via a closed loop system with no exhaust to the atmosphere.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Assuming 10,000 tonnes for 1 year, 50% moisture level and dried for haulage : $1,100,000 (US).

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Hygrex-Spehr Industries
680 Hardwick Drive, Unit 4
Bolton, Ontario
Canada L7E 5T3
Notes

Contact: Spehr, E.
Phone: (905) 857-3331 Ext:
Fax: (905) 857-3330
Email:

Vendors:

Hygrex-Spehr Industries
680 Hardwick Drive, Unit 4
Bolton, Ontario
Canada L7E 5T3
Notes

Contact: Spehr, E.
Phone: (905) 857-3331 Ext:
Fax: (905) 857-3330
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

IHC Metal Extraction

19-Jan-98

TechID: 104

Technology Type: Metal Extraction

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

Extractive decontamination involves the removal of heavy metals from dredged sediment. These metals can be removed by extracting the silt with acid or complexing agents. There is also a micro-biological extraction method which utilizes a specific micro-organism to produce the acid which leaches out the metals. Either method can be applied on a large scale in a depot, or more intensively in a plant.

Limitations:

Efficiency Description: Up to 90% removal

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $50.00 – $100.00 Average Cost (US$/Tonne): $75.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleaned soil (sludge), reusable water, and metal concentrate

Developers:

TNO-IMET
Laan van Westerenk 507, Postbus 342
Apeldorn, AH
The Netherlands 7300 -
Notes

Contact:
Phone: 31 55 493493 Ext:
Fax: 31 55 419837
Email:

Vendors:

IHC Dredge Technology Corporation
P.O.Box 1520, 148 Oakwood Dr.
Wayne, N.J.
USA 07474-1520
Notes

Contact: Ouwerkerk, R.
Phone: (201) 696-1559 Ext:
Fax: (201) 696-3572
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Innovat Mackie Vat Leaching Jig (MVLJ)

19-Jan-98

TechID: 127

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

The MVLJ consists of a pit or tank equipped with a grid of drains at its bottom. Water is flushed through the system to mix, wash and classify the soil being treated. Designed to leach precious metals from ores, investigations are underway with Athabasca Research of Edmonton to apply the technology to soil washing.

The heating of the water along with the addition of solvents could possibly wash soils of other contaminants. At the same time, the MVLJ is a suitable reaction vessel offering good contact between soil particles and gas/liquid reactants/solvents. Research, at both bench and pilot scale, is being conducted at Ortech International in Mississauga.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): **0.1**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Innovat
474 Copeland Court., P.O.B. 61018
Oakville, Ontario
Canada L6J 7P5
Notes

Contact: Mackie, D.A.
Phone: (905) 469-0505 Ext:
Fax: (905) 469-1062
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Innovat Solidification and Stabilization

19-Jan-98

TechID: 111

Technology Type: Stabilization/Fixation

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

Innovat has a patent-pending method of making grouts, mortars, and concrete by using sludges from acid water neutralization in the mining industry and elsewhere. Research work is proposed for LAC Mines and Falconbridge, Ltd. for this technology in making backfill, stabilizing tailings and for capture of heavy metals from hydroxides.

It is proposed to test the MVLJ, Innovat's extraction technology, as a pre-treatment to this technology in the production of lightweight aggregates.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Innovat
474 Copeland Court., P.O.B. 61018
Oakville, Ontario
Canada L6J 7P5
Notes

Contact: Mackie, D.A.
Phone: (905) 469-0505 Ext:
Fax: (905) 469-1062
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

In-Situ Fixation Inc., Dual Auger System - Bioremediation

19-Jan-98

TechID: 63

Technology Type: Biological, Chemical, Stabilization/Fixation
Soil Vapour Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX, Explosives

Media Treated: Sediment In-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Our Biodegradation Process consists of the in-situ injection and mixing of speciallly selected site-specific or waste acclimated microorganisms with the contaminated soil. Our process thoroughly blends the microorganisms with the entire mass of soil being treated, thus assuring total and sustained contact with all toxins present. Additionally, our process breaks up stratas and dense soils present, thus allowing for the transfer of oxygen or other electrons. The bacteria are augmented with specific nutrients, which improve the biomass environment to accelerate enzymatic degradation of the targeted pollutants. The microorganisms and nutrients are naturally occurring, non-toxic, non-pathogenic, non-polluting and not hazardous to plant, animal or human life. Our biodegradation process will breakdown the toxic waste material to yield end products such as carbon dioxide and water, thus producing a finished product which is safe and meets all E.P.A. requirements.

Limitations: Large underground obstructions over one (1) foot in diameter, rock stratas and overhead height restrictions.

Efficiency Description: >98%

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Class A General Engineering Contractors License.

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 2
Feed Rate Average (Tonne/hr): 150

Cost: Capital Cost (US$):
Treatment Cost (US$/Tonne): $30.00 – $75.00 Average Cost (US$/Tonne): $50.00
Permits and treatability studies not included in unit costs.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Dual Auger System is equipped with a hood that captures and treats any air borne contaminants.

Developers:

In-Situ Fixation Inc.
P.O.Box 516
Chandler, AZ
USA 85244-0516
Notes

Contact: Murray, Richard P.
Phone: (601) 821-0409 Ext:
Fax: (602) 786-3184
Email:

Vendors:

In-Situ Fixation Inc.
P.O.Box 516
Chandler, AZ
USA 85244-0516
Notes

Contact: Murray, Richard P.
Phone: (601) 821-0409 Ext:
Fax: (602) 786-3184
Email:

Literature References:

Author: **Tittlebaum, M.E., Eaton, H.C., Cartledge, F.K., Walsh, M.B., Roy, A.**
Title: Procedures for Characterization Effects of Organics on Solidification/Stabilization of Hazardous Wastes
Journal: Hazardous and Industrial Solid Waste Testing and Disposal, Sixth Volume Date: **Jan 1986**

Author: **Irvine, R.L., Earley, J.P., Kehrberger, G.J., Delancy, B.T.**
Title: Bioremediation of Soils Contaminated with Bis (2-ethylhexyl) Phthalate (BEHP) in a Soil Slurry-Sequencing Batch Reactor
Journal: Environmental Progress, Vol. 12, No. 1 Date: **Jan 1993**

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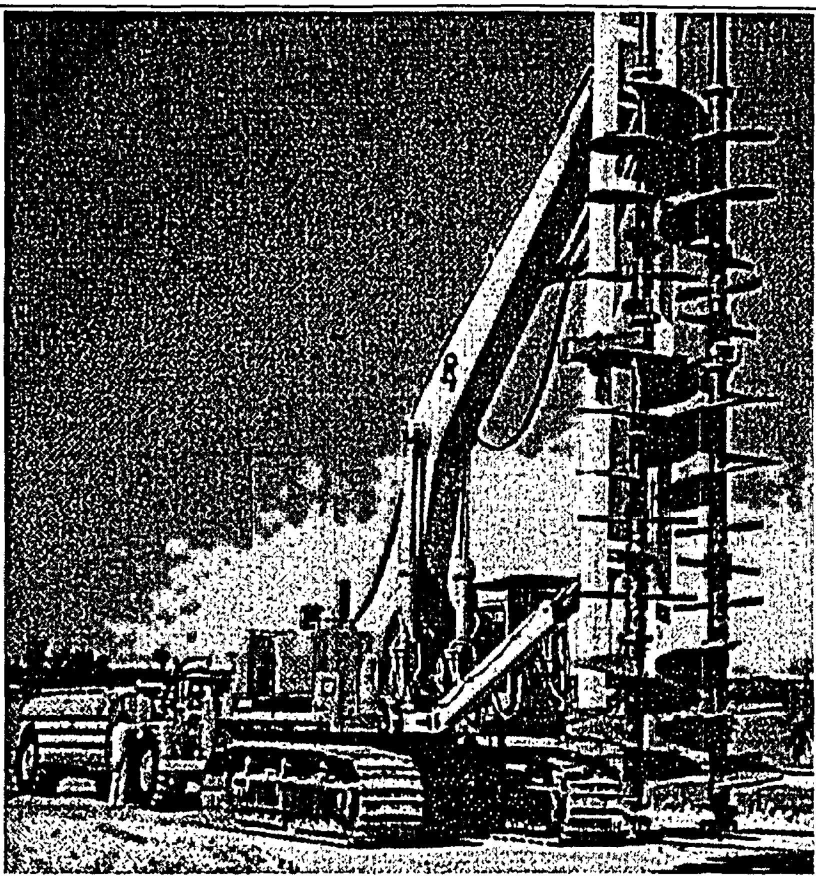
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

In-Situ Fixation Inc., Dual Auger System - Bioremediation

19-Jan-98



Project: Seabury Chevrolet

Location: Yuma, Arizona, USA

Year:

Full Scale Demo

Client/Funding Agency	Contact	Phone
Ariz. Dept. of Environmental Quality	Les Glascoe	(602) 207-2300
R. Seabury	R. Seabury	(520) 726-5500

Not Audited

Feed Rate (Tonne/hr): 100

Amount Treated (Tonne): 5000

Treatment Cost (US$): $175,000.00

Setup Time (days): 3

Breakdown Time (days): 2

Media Treated: Soil

Contaminants Treated: TPH

Cleanup Goals: 100 ppm TPH.

Emissions/ByProducts:

Description:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

In-Situ Fixation Inc., Dual Auger System - Solidification/Stabilization

19-Jan-98

Technology Type: Biological, Chemical, Stabilization/Fixation TechID: 64

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX, Explosives

Media Treated: Sediment In-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Our Chemical Fixation Process alters substances by a combination of changes in chemical composition and physical characteristics. The immobilizing matrix produced presents both chemical and physical barriers to the leaching of contaminants by ground water. The process is specifically designed for treatment of in-place contaminated subsurface soils and wastes. Our process involves mixing fixative reagents(s) contained in a pozzolanic slurry with the hazardous substances and can render them nonhazardous, chemically inert and mechanically stable. The resultant product posseses chemical and physical properties which differ drastically form those of the parent waste. This unique transformation produces the following fundamental changes:

1) Toxic constituents originally present in the untreated waste undergo chemical changes to become different compounds with reduced solubility and toxicity.

2) The fixated waste takes the form of a solidified mass (monolith) with improved physical characteristics, including incresased strength and reduced permeability.

3) The resulting matrix microencapsulates the waste, isolating the toxic chemicals from the ground and the atmosphere. The mobility of the toxicant is drastically reduced, minimizing or eliminating migration of the pollutants, while at the same time meeting TCLP leach requirements.

Limitations: Large underground obstructions over one (1) foot in diameter, rock stratas and overhead height restrictions.

Efficiency Description: >98%

Government Funding: SITE

Environmental Concerns: see below

Health & Safety Plan Available: ☒

Regulatory Approvals Class A General Engineering Contractors License.

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 150

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $30.00 – $75.00 Average Cost (US$/Tonne): $50.00

Permits and Treatability Studies not included in unit costs. Quotation is for sediment contaminated with Diesel and Waste Oil. Capital cost not available.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Dual Auger System is equipped with a hood that captures and treats any air borne contaminants.

Developers:

In-Situ Fixation Inc.
P.O.Box 516
Chandler, AZ
USA 85244-0516
Notes

Contact: Murray, Richard P.
Phone: (601) 821-0409 Ext:
Fax: (602) 786-3184
Email:

Vendors:

In-Situ Fixation Inc.
P.O.Box 516
Chandler, AZ
USA 85244-0516
Notes

Contact: Murray, Richard P.
Phone: (601) 821-0409 Ext:
Fax: (602) 786-3184
Email:

Literature References:

Author: **Tittlebaum, M.E., Eaton, H.C., Cartledge, F.K., Walsh, M.B., Roy, A.**
Title: Procedures for Characterizing Effects of Organics on Solidification/Stabilization of Hazardous Wastes
Journal: Hazardous and Industrial Solid Waste Testing and Disposal, Sixth Volume Date: **Jan 1986**

Author: **Irvine, R.L., Earley, J.P., Kehrberger, G.J., Delancy, B.T.**

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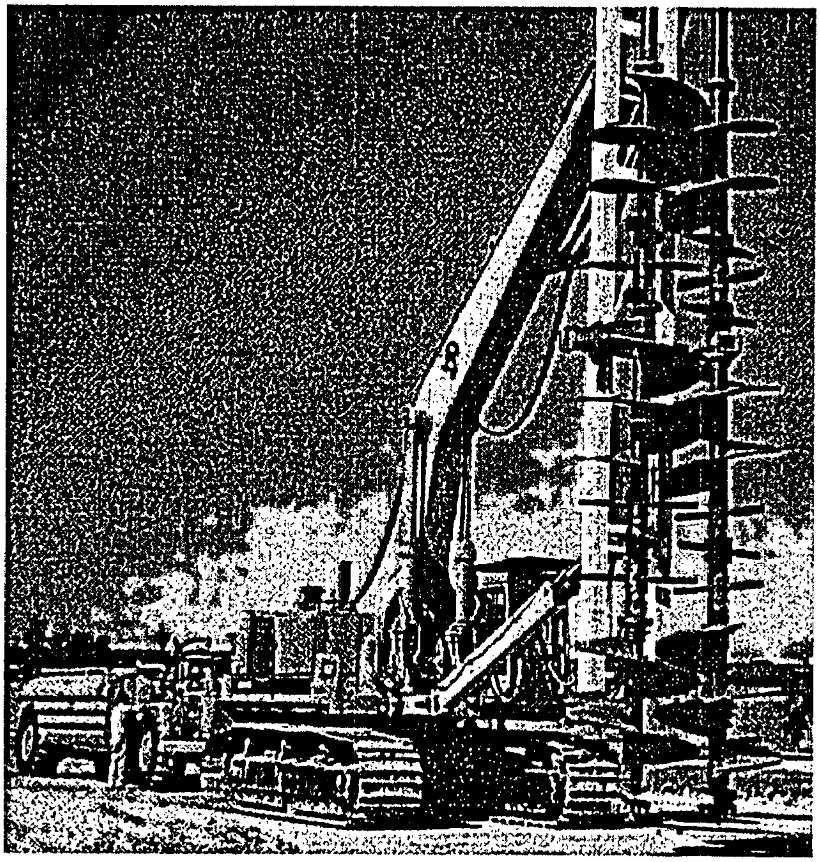
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

In-Situ Fixation Inc., Dual Auger System - Solidification/Stabilization

19-Jan-98

Title: Bioremediation of Soils Contaminated with Bis (2-ethylhexyl) Phthalate (BEHP) in a Soil Slurry-Sequencing Batch Reactor
Journal: Environmental Progress, Vol. 12, No. 1 Date: **Jan 1993**



Project: Seabury Chevrolet
Location: Yuma, Arizona, USA

Year:
Full Scale Demo

Client/Funding Agency	Contact	Phone
Ariz. Dept of Environmental Quality R. Seabury	Les Glascoe Robert Seabury	(602) 207-2300 (520) 726-5500

Not Audited

Feed Rate (Tonne/hr): 100 Amount Treated (Tonne): 5000
Treatment Cost (US$): $175,000.00
Setup Time (days): 3 Breakdown Time (days): 2
Media Treated: Soil
Contaminants Treated: Cleanup Goals: 100 ppm TPH
Emissions/ByProducts:
Description:

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Institute of Gas Technology, Biological-Chemical Process

19-Jan-98

TechID: 100

Technology Type: Biological

Contaminants Treated: PAH's, PCB's, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The proposed process involves the initial separation of the solid-water mixture through solvent washing. The two fractions are then treated separately in aerobic bioreactors. If all organic pollutants are not completely removed a chemical co-treatment can be applied to enhance the degradation.

The technology has been successfully employed in the degradation of volatile hydrocarbons, PAHs and PCBs.

Limitations:

Efficiency Description: 80%-90% in a few weeks

Government Funding: Great Lakes Cleanup Fund, ETP

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Cleansed soil/sediment, biomass, carbon dioxide and water

Developers:

Institute of Gas Technology
1700 Mt. Pleasant Rd.
Des Plaines, IL
USA 60018-
Notes

Contact: Srivastava, V.J.
Phone: (847) 768-0539 Ext:
Fax: (847) 768-0546
Email: srivasta@igt.org.

Literature References:

Author: **Conrad, J.R., Srivastava, V.J., Pradhan, S.**
Title: Final Report: Bench Scale Studies of Biological-Chemical Remediation for Treatment of Contaminated Hamilton Harbor
Journal: Sediment, Canada
Prepared for Great Lakes Cleanup Fund Date: Nov 1992

Author: **Wastewater Technology Centre**
Title: IGT Biological-Chemical Bench-Scale Remediation Project
Journal: GLCF Fact Sheet Number 11 Date: Apr 1994

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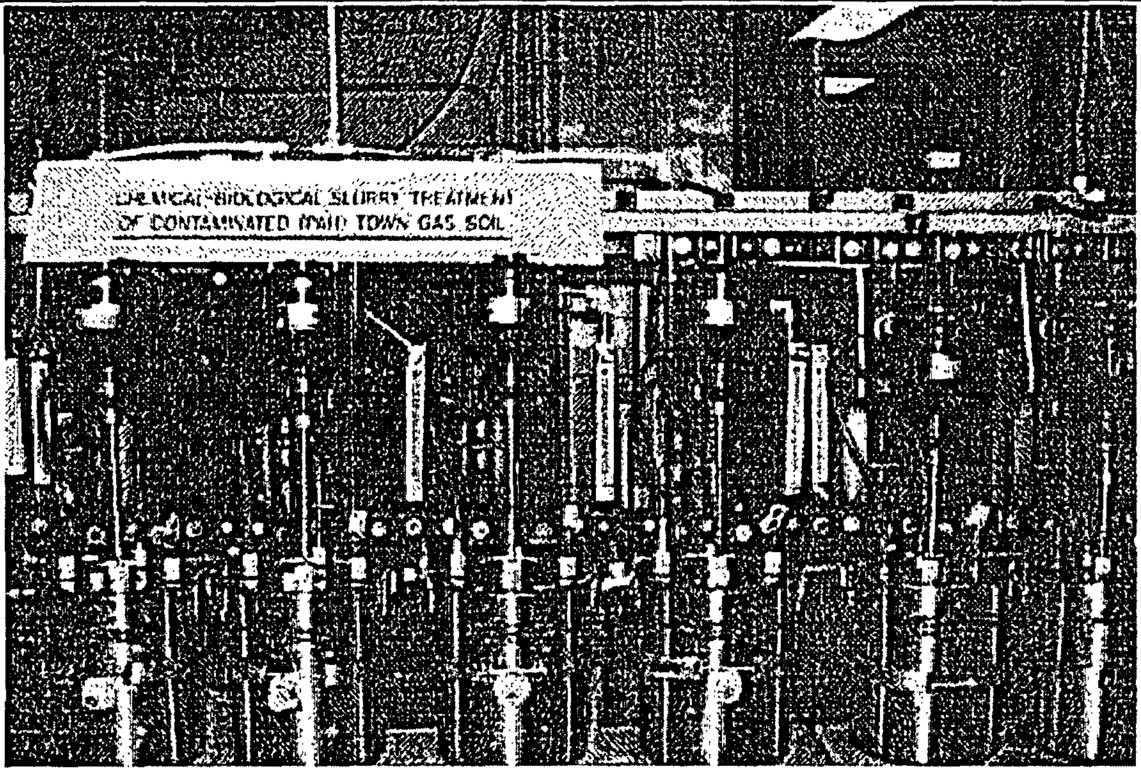
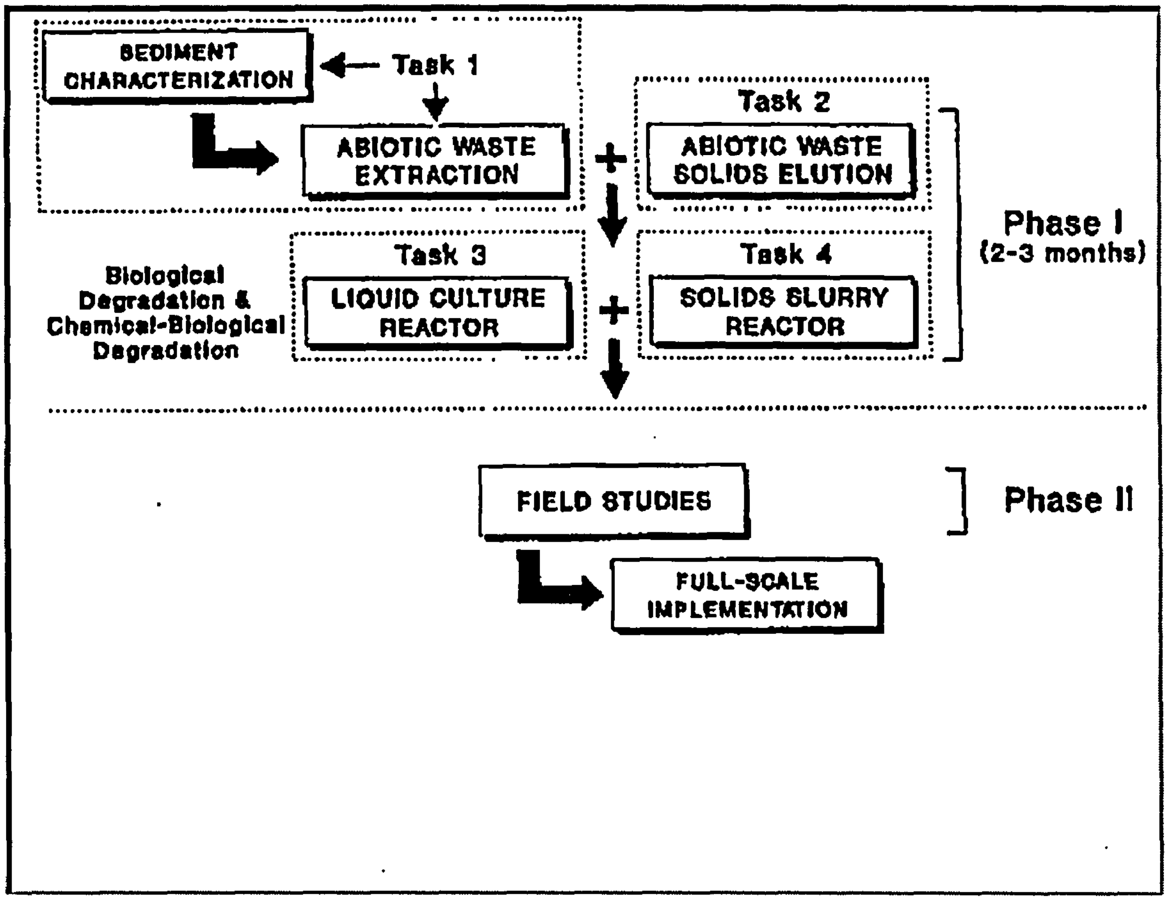
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.





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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Institute of Gas Technology, Biological-Chemical Process

19-Jan-98

Project: Hamilton Harbour Sediment **Year: 92**

Location: Hamilton, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment containing 59% sand, 36% silts and about 5% clay with total EPA identified pollutant levels of approximately 900ppm and carcinogenic PAH levels of 125 ppm.

Contaminants Treated: PAH's and heavy metals.

Emissions/ByProducts:

Description: Hamilton Harbour sediment was tested at IGT's facilities in Chicago. The sediment was known to be contaminated by organics and heavy metals. This demonstration targeted the organic contaminants known as polynuclear aromatic hydrocarbons (PAH's). Solids slurry experiments were performed with the sediments to determine what treatment endpoints might be achieved using the biological alone and a combination of chemical-biological treatments. Five different treatment conditions were evaluated using 10% (w/v) sediment solids slurries. All treatments were sampled at 0, 1, 7, 21, 28, 42 and 51 days.

RESULTS
See Figure.
The most effective treatment for PAHs involved bioaugmentation with IGT's culture only. EPA total and carcinogenic PAH levels were reduced 90% and 78% respectively. IGT propose that a treatment scheme for cleaning the Hamilton Harbour sediment would consist of sediment solids/liquid separation followed by aerobic bioremediation of the two streams.

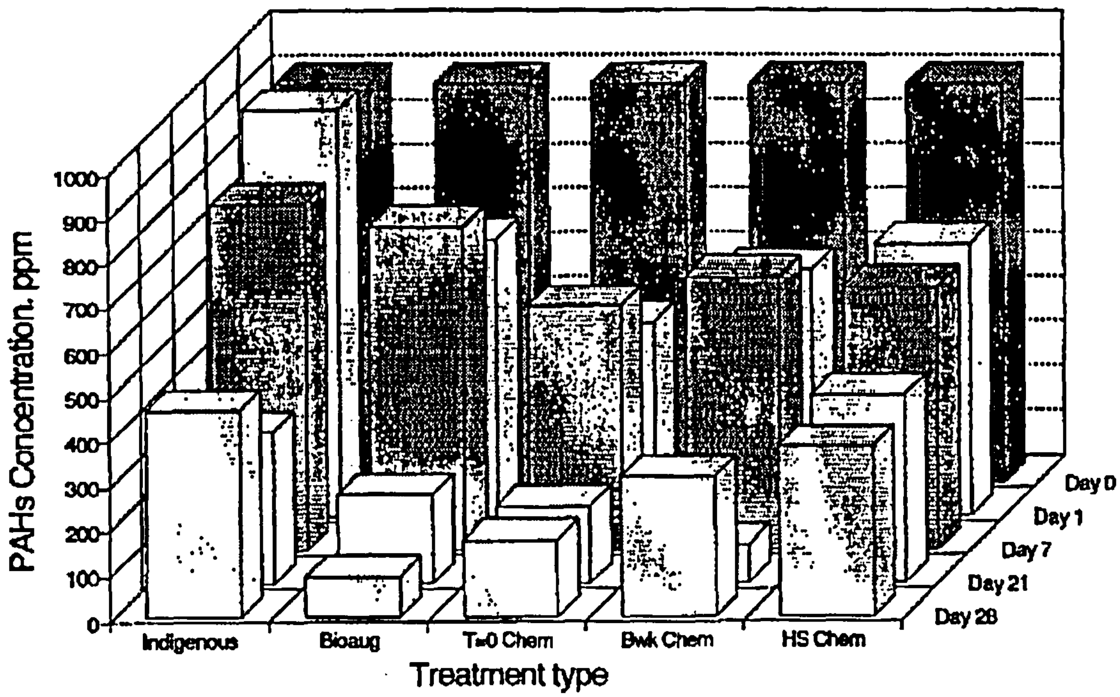

Figure 4. RESIDUAL TOTAL EPA PAH LEVELS IN SEDIMENT SOLIDS SLURRY REACTORS UNDER VARIOUS TREATMENT CONDITIONS

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Institute of Gas Technology, Extraction/Biological Degradation Process

19-Jan-98

Technology Type: Organic Extraction TechID: 101

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The proposed process invloves three separate technologies - extraction, separation, and bioremediation.

The extraction is performed within a pressure chamber using a supercritical gas. The supercritical gas is recycled during the separation step. Release of the contaminants bound to the soil, enhances their bioavailability.

Separation of the contaminants to a biologically compatible fluid enables the extraction fluid to be recycled and the organic contaminants to be biodegraded by a variety of microorganisms. Non-biodegradable contaminants would be separated for alternative treatment.

Limitations:

Efficiency Description:

Government Funding: ETP

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean sediment, carbon dioxide, water and biomass

Developers:

Institute of Gas Technology
1700 Mt. Pleasant Rd.
Des Plaines, IL
USA 60018-
Notes

Contact: Srivastava, V.J.
Phone: (847) 768-0539 Ext:
Fax: (847) 768-0546
Email: srivasta@igt.org.

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Institute of Gas Technology, Two-Stage Combustor

19-Jan-98

TechID: 102

Technology Type: Incineration
Thermal Detoxifier

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The "Two-Stage Fluidized-Bed/Cyclonic Agglomerating Combustor" was developed through improvements on combination of IGT's fluidized-bed and cyclonic combustion systems. Key features in the system include the patented sloped grid in the fluidized-bed, and a precise ash discharge port. While organics are destroyed in the process, inorganics are vitrified into glassy, non-leachable pellets along with the soil or sediment. The second stage cyclonic combuster process insures the >99.99% DRE of contaminants and low level production of NOx.

Limitations:

Efficiency Description: >99.99% for POHC's

Government Funding: ETP

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.7

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $50.00 – $100.00 Average Cost (US$/Tonne): $70.00

Estimated costs: For 4 tonne/hour unit: $70.00 - $100.00 US/tonne. For 10 tonne/hour unit: $50.00 - $65.00 US/tonne. Does NOT include excavation costs or environmental permitting costs.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Vitrified sediment and inorganic contaminants, and scrubbed flue gases

Developers:

Institute of Gas Technology
1700 S. Mt. Prospect Rd.
Des Plaines, IL
USA 60018-

Contact: Rehmat, A.
Phone: (847) 768-0588 Ext:
Fax: (847) 768-0600
Email: arehmat@igt.org

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

International Waste Technology, Advanced Chemical Treatment

19-Jan-98

TechID: 106

Technology Type: Chemical, Stabilization/Fixation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Tributyl-Tin, Mercury, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Sulphides

Media Treated: Sediment Ex-Situ, Sediment In-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The Advanced Chemical Treatment Process (ACT) manifests the Reactive Geology (TM) during chemical reactions with the contaminated soil or sediment. ACT is an effective and relatively cost-efficient treatment of sediments, soils, and sludges contaminated with toxic metals, organics and inorganic compounds that continues to work for an indefinite period. Toxic organics are immobilized or constrained initially and then thermally altered to innocuous compounds which can contain significant amounts of calcium carbonate or esters. This would be the natural result of an oxidation process of organic compounds in the presence of calcium oxide and appropriate surface and pore water chemistry.

No form of treatment destroys elements. The maximum any form of waste treatment can achieve is a molecular alteration or rearrangement to a new and safe end-state and this is also true with ACT. The ACT process does not leach carbon dioxide and monoxide into the matrix in the form of calcium carbonate. In other words some of the organics can be mineralized. Toxic metals are immobilized into insoluble mineral entities that become part of the matrix. The objective of Reactive Geology is mineralization.

Limitations:

Efficiency Description:

Government Funding: SITE

Environmental Concerns: Long term monitoring 60 to 90 days.

Health & Safety Plan Available: ☒

Regulatory Approvals # A 680050; MOEE Certificate of Approvals

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 100

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): $100.00 – $200.00 Average Cost (US$/Tonne): $150.00

Based on preliminary lab study, excavation stockpile, treatment and replacement. Depends on extent of contamination.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide and water

Developers:

International Waste Technology
150 North Main, Suite 910
Wichita, KS
USA 67202-
Notes

Contact: Newton, J.P.
Phone: (316) 269-2660 Ext:
Fax: (316) 269-3865
Email:

Vendors:

Harbour Remediation and Transfer Inc.
97 Commissioners St.
Toronto, Ontario
Canada M5P1A6
Notes

Contact: Costa, C.
Phone: (416) 406-0509 Ext:
Fax: (416) 406-0476
Email:

Literature References:

Author: Miyamoto, H.K., Costa, C., Newton, J.
Title: Laboratory Investigation into the Fate of Anthracene and Acenaphthene in Soil Treated with WHT-25
Journal: Presented at the 77th Canadian Society for Chemistry Conference, 1994, Winnipeg, Manitoba, Canada Date: May 1994

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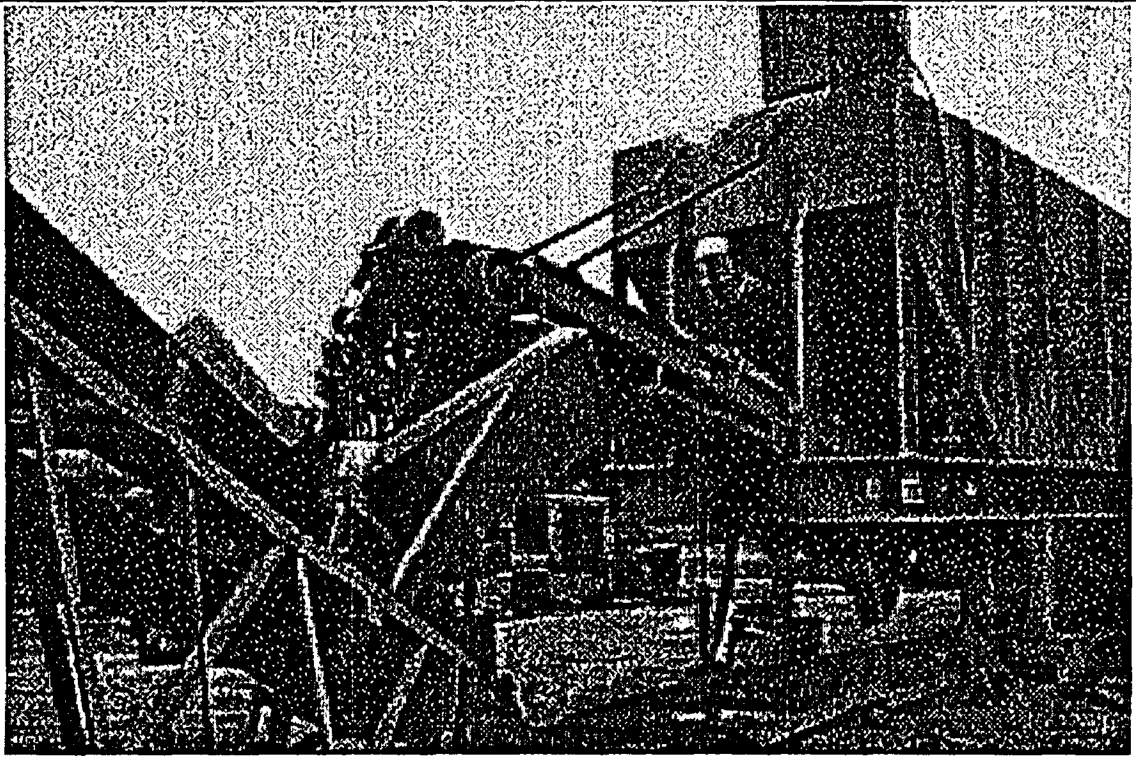
International Waste Technology, Advanced Chemical Treatment 19-Jan-98



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International Waste Technology, Advanced Chemical Treatment

19-Jan-98

Project: Harbour Lands - MOEE Lab Investigation — **Year: 93**

Location: Toronto, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 100 — Amount Treated (Tonne): 10000

Treatment Cost (US$): $725,000.00

Setup Time (days): 5 — Breakdown Time (days): 5

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal	Unt. Leach.	Tr. Leach.
PAH's	185 ug/g	5	97		
Lead	60,000 ug/g	> 0.5		300	7.05

Cleanup Goals: CCME - Commercial - Industrial Leachate; TCLP & use of soils on site.

Emissions/ByProducts:

Description: Bench Scale - Anthracene and acenapthene - on clean sand spiked with hazardous levels of above (see contaminants).

Project: Pilot of Harbour Lands — **Year: 93**

Location: Toronto, Ontario, Canada — Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 100 — Amount Treated (Tonne): 10000

Treatment Cost (US$):

Setup Time (days): 5 — Breakdown Time (days): 5

Media Treated: Soil

Contaminants Treated: PAH's
Lead

Cleanup Goals: CCME - Commercial - Industrial Leachate; TCLP & use of soils on site.

Emissions/ByProducts:

Description: Pilot - Soils and residues from various soils of Harbour Lands.

Project: MOEE Lab Investigation — **Year: 93**

Location: Toronto, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 100 — Amount Treated (Tonne): 10000

Treatment Cost (US$):

Setup Time (days): 5 — Breakdown Time (days): 5

Media Treated:

Contaminants Treated: PAH's
Lead

Cleanup Goals: CCME - Commercial - Industrial Leachate; TCLP & use of soils on site.

Emissions/ByProducts:

Description: Heavy metal treatment of solid non-hazadous soils from St. Lawrence Housing Project.
Bullet range clean-up of lead in Bronx, New York.

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ISI Krofchak Solidification and Stabilization

19-Jan-98

TechID: 115

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

Utilizing a variety of chemical reagents waste materials, along with the sediment with which they are associated, are solidified into a silicate compound. Synthetic stone or soil is produced. This product is then disposed of as a non-hazardous material with MOE approval.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.9

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $44.00 – $44.00 Average Cost (US$/Tonne): $44.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Inorganic solid containing contaminants

Developers:

International Solidification Inc.
256 Bronte Rd.
Oakville, Ontario
Canada L6L 3C6
Notes

Contact: Krofchak, D.
Phone: (905) 825-0003 Ext:
Fax:
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

ITC Thermal Separator

19-Jan-98

TechID: 105

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Contaminated solids are fed to an externally heated rotary drum. The soil can attain tempertures of 200 to 600 degrees Celsius, resulting in vapourization of organic contaminants. The vapours are carried out of the drum by an inert purge gas flowing counter current to the solids flow. Organic vapours enter a gas quenching/condensing system for disposal/further treatment or reuse.

The major factors affecting performance are soil temperature and time for which this temperature is maintained.

Tests with PCB contaminated soils resulted in almost all residual PCB levels being less than 2ppm. Experiments with PAH contaminated soils resulted in 88% to greater than 99% removal depending on the test parameters.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Pilot testing under RCRA treatability exemption and TSCA R&D permit

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.009

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $80.00 – $80.00 Average Cost (US$/Tonne): $80.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean solids, clean gas, non-contact flue gas

Developers:

International Technology Corporation
304 Directors Drive
Knoxville, TN
USA 37923-
Notes

Contact: Alperin, E.
Phone: (615) 690-3211 Ext:
Fax: (615) 694-9573
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Izone Ozone Oxidation-Reduction Chamber

19-Jan-98

TechID: 112

Technology Type: Chemical

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Expanding from the water purification market, Izone has developed a mobile treatment unit for the processing of various chlorinated hydrocarbons. The technology involves the use of ozone as an oxidation agent to break down contaminants into carbon dioxide and water. Tests on PAHs have reduced their concentration to below the detection limit of 0.001mg/l with a single run while other contaminants have required multiple runs for given criteria.

As work has been targetted towards the effluent from pulp mills given data is media specific and adaptation to sediment would require labratory and bench scale work. A proposal has been forwarded to use an emulsifying agent to free hydrocarbons from the sediment into water for treatment.

Limitations:

Efficiency Description: 54% with single pass, greater with multiple runs, specifically: zero discharge of PAHs, PCBs, TCE, TCB; AOX 87% single - 93% multi-pass.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Not required unless dealing with PCBs if client has a discharge permit in place.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.00006

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide and water

Developers:

Izone International Ltd.
Suite 1027-470 Granville
Vancouver, BC
Canada V6C 1W3
Notes

Contact: McFadden, J.
Phone: (604) 681-6510 Ext:
Fax: (604) 681-9507
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

J.R. Simplot Co., SABRE Process for Nitroaromatic-Contaminated Soils

19-Jan-98

TechID: 361

Technology Type: Biological

Contaminants Treated: Pesticides/Herbicides, Explosives

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☒

Description:

The SABRE process employs a bioreactor equipped for monitoring and periodic mixing. Excavation, screening, homogenization and possibly specialized separation equipment are required to prepare contaminated soils prior to introduction into the bioreactor. All equipment selected for final remediation is portable, modular and readily adaptable in the field. The soil is first screened to desired size, usually to one inch. Oversized material is water washed and undersized material is placed in the bioreactor with the oversize wash water.

For small commercial remediation sites, small portable bioreactors can be utilized. At larger sites, modular reactors or open lined pits can be utilized. When operated in the batch mode, each batch receives the specially-selected SABRE inoculum, which decreases the amount of time needed to degrade the nitroaromatics. During treatment, personnel are not required to be on site full time.

The SABRE process is dependent on pH, redox potential, and temperature. Field trials show that once the SABRE process was begun, pH targets were easily achieved and maintained. A redox potential of less than -200 mV is sufficiently low to maximize degradation rates. During bench scale treatability studies, it was determined that the optimum reaction temperature was 35 to 37 °C. Field results show that a reactor temperature as low as 18 °C could sustain degradative activity.

During periodic agitation of the reactor, the solid phase is recontacted with the liquid in a manner preventing aeration of the liquid. Treatability studies and field trials have shown that these semi-static systems will achieve acceptable results when soil, water, and carbon sources are well mixed during loading of the bioreactor.

CURRENT STATUS:

The University of Idaho in cooperation with the Simplot Company have ongoing research programs to design improvements in this process and expand the applicability of this technology to specific sites and for additional chemical compounds. Additional work is being conducted to develop an in-situ process for subsurface soil and groundwater. Simplot maintains an active research program at our research facilities located in Pocatello, Idaho. An expanding staff of researchers conduct basic microbiological research, perform treatability tests and supervise field trials and commercial applications of the technology.

Work plans have been prepared for agency approval for full-scale remediation of 7700 m^3 of TNT-contaminated soils to begin at Iowa Army Ammunitions Plant in the summer of 1996. Full-scale commercial dinoseb remediation using the SABRE process has been approved by state agencies for a site at Ellensburg, Washington, USA. Field-scale remediation has already proven highly effective at Ellensburg.

Additional laboratory treatability work is being performed using the SABRE process on explosive-contaminated soils from several U.S. Navy bases by the Army Corps of Engineers - Waterways Experiment Station in Vicksburg, Mississippi, USA.

Because this is a proprietary technology and patented, all work with the technology has been and will be conducted with the approval and under the direction and supervision of the J.R. Simplot Company.

Limitations: High concentrations (> 2000 ppm) heavy metals prevent treatment; TPH > 1500 ppm may increase treatment time as will the presence of multiple nitroaromatic contaminants.

Efficiency Description: > 90%

Government Funding: SITE

Environmental Concerns: May require permitting to release soil back to site after treatment.

Health & Safety Plan Available: ☐

Regulatory Approvals California Technology Evaluation Program

Setup/Feed: Setup Time (days): 4 Breakdown Time (days): 4

Feed Rate Average (Tonne/hr): 0.15

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $125.00 – $350.00 Average Cost (US$/Tonne): $200.00

Assuming soil or sediment treated ex-situ for TNT, RDX, HMX or DNT.

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products: Treated soil/sludge and buffered water.

Developers:

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J.R. Simplot Co., SABRE Process for Nitroaromatic-Contaminated Soils

19-Jan-98

J.R. Simplot Company
P.O.Box 912
Pocatello, ID
USA 83201-
Notes

Contact: Kaake, Russell
Phone: (208) 234-5367 Ext:
Fax: (208) 234-5339
Email:

Vendors:

J.R. Simplot Company
P.O.B. 912
Pocatello, ID
USA 83201-
Notes

Contact: Yergovich, Tom
Phone: (208) 238-2850 Ext:
Fax: (510) 939-7513
Email: tyergovich@simplot.

J.R. Simplot Company
P.O.Box 912
Pocatello, ID
USA 83201-
Notes

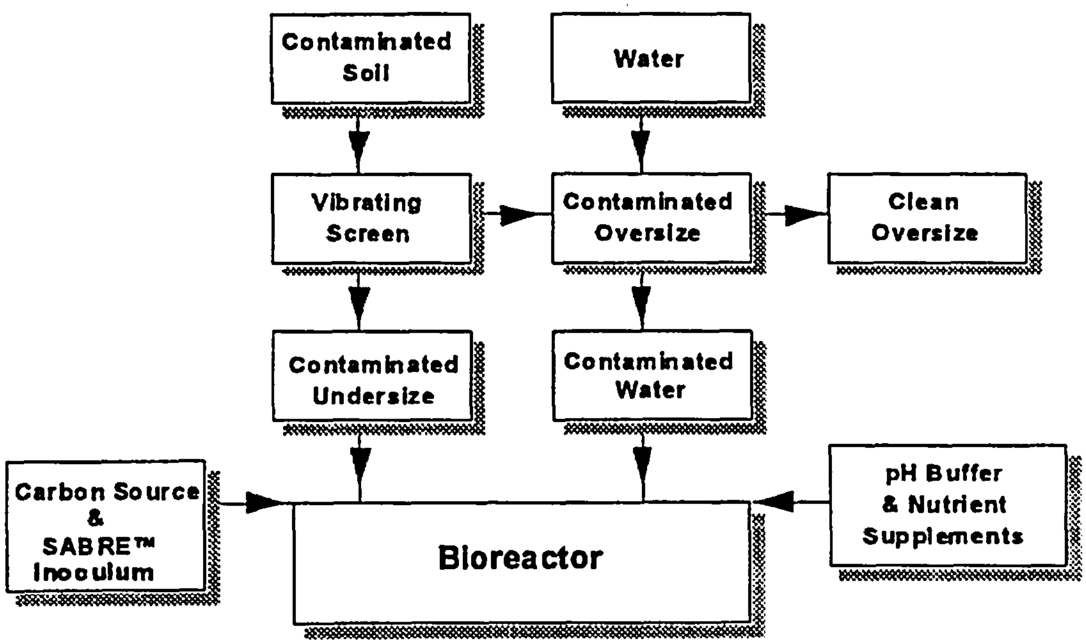
Contact: Kaake, Russell
Phone: (208) 234-5367 Ext:
Fax: (208) 234-5339
Email:

Literature References:

Author: **Kaake, R.H., Roberts, D.J., Stevens, T.O., Crawford, R.L., et al**
Title: Bioremediation of Soils Contaminated with Dinoseb
Journal: Applied and Environmental Microbiology
Date: **May 1992**

Author: **Funk, S.B., Roberts, D.J., Crawford, D.L., et al**
Title: Initial-Phase Optimization for Bioremediation of Munition Compound-Contaminated Soils
Journal: Applied and Environmental Microbiology
Date: **Jul 1993**

Author: **U.S. EPA**
Title: J.R. Simplot Ex-Situ Bioremediation Technology for Treatment
Journal: EPA/540/R-95/529
Date: **Sep 1995**



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J.R. Simplot Co., SABRE Process for Nitroaromatic-Contaminated Soils

19-Jan-98

Project: Reedley Soilbuilders Dinoseb Site - Full Scale **Year: 95**

Location: Reedley, CA, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Site Owner/Insurance		

Not Audited

Feed Rate (Tonne/hr): 0.6 Amount Treated (Tonne): 440

Treatment Cost (US$): $144,000.00

Setup Time (days): 5 Breakdown Time (days): 5

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
Dinoseb	500 mg/kg	< 2.5 mg/kg	> 99.5

Clean-up Goals: Dinoseb treatment goal: 2.5 mg/kg.

Emissions/ByProducts: 38 m^3 water

Description: Approval received from California EPA to replace soil and water into unlined evaporation pond on-site. Produced 440 tonnes treated soil and 38 m^3 treated water (met drinking water standards); both phases returned to site.

Project: Bangor Naval Submarine Base - Site D **Year: 94**

Location: Silverdale, WA, USA

Pilot Scale

Client/Funding Agency	Contact	Phone
US Navy		

Not Audited

Feed Rate (Tonne/hr): 0.05 Amount Treated (Tonne): 15

Treatment Cost (US$):

Setup Time (days): 4 Breakdown Time (days): 4

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:
TNT	725 mg/kg	< 33 mg/kg	< 90

Clean-up Goals: TNT: 33 mg/kg

Emissions/ByProducts: Water

Description:

Project: Bangor Naval Submarine Base - Site F **Year: 94**

Location: Silverdale, WA, USA

Pilot Scale

Client/Funding Agency	Contact	Phone
US Navy		

Not Audited

Feed Rate (Tonne/hr): 0.06 Amount Treated (Tonne): 15

Treatment Cost (US$):

Setup Time (days): 4 Breakdown Time (days): 4

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
TNT	488 mg/kg	0.7 mg/kg	> 99
RDX	22 mg/kg	0.5 mg/kg	> 97
HMX	30 mg/kg	7.2 mg/kg	76

Clean-up Goals: TNT: 33 mg/kg; RDX: 9.1 mg/kg; HMX: none

Emissions/ByProducts: Water

Description: Side by side comparison with composting on-site.

Project: Weldon Spring Ordnance Works **Year: 92**

Location: Weldon Spring, MO, USA

Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA	Wendy Davis-Hoover	(513) 569-7206

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Not Audited

Feed Rate (Tonne/hr): 0.15 Amount Treated (Tonne): 53

Treatment Cost (US$):

Setup Time (days): 5 Breakdown Time (days): 4

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
TNT	1500 mg/kg	7.8 mg/kg	>99.4

Clean-up Goals: TNT 33 mg/kg

Emissions/ByProducts: Water

Description: No heating and minimal stirring of reactor contents (i.e. non-optimum conditions). Treatment continued once reactor contents thawed in spring. Part of EPA SITE program.

Project: Bower's Field **Year: 92**

Location: Ellensburg, WA, USA

Pilot Scale

Client/Funding Agency	Contact	Phone
EPA	Wendy Davis-Hoover	(513) 569-7206

Not Audited

Feed Rate (Tonne/hr): 0.08 Amount Treated (Tonne): 53

Treatment Cost (US$):

Setup Time (days): 5 Breakdown Time (days): 3

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
Dinoseb	23 mg/kg	< 0.0025 mg/kg	> 99.9

Clean-up Goals: Dinoseb: 2.5 mg/kg

Emissions/ByProducts: Water

Description: Treatment performed under sub-optimal conditions (18° C).

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Jacques Whitford Environment Ltd., Bioslurping Treatment System

19-Jan-98

TechID: 332

Technology Type: Biological

Soil Vapour Extraction; Hydraulic Containment

Contaminants Treated: PAH's, PCB's, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil In-Situ

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The Bioslurping Transportable Remediation Unit (TRU) represents an innovative, unique and hybrid approach to petroleum remediation by employing a variety of aggressive remediation technologies including 1) High vacuum multiphase/total fluids dewatering of free-phase liquid hydrocarbons and groundwater; 2) Soil vapour extraction using the same high vacuum pumps; 3) Nutrient and water injection for enhanced in-situ bioremediation using the same piping network as for extraction; 4) Groundwater treatment using oil/water separation, air stripping and carbon polishing; and 5) Optional air sparging.

The combination of these technologies allows for rapid remediation of a wide range of petroleum hydrocarbon contaminants in the saturated and unsaturated zones.

Limitations: Cannot treat metals in soils. Total fluids dewatering capability 8 m below grade; this limitation can be easily overcome using submersible pumps and/or buried knockout drums.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Ontario MOEE C of A (Air); Ministry of Labour/Ontario Hydro.

Setup/Feed: Setup Time (days): **20** Breakdown Time (days): **2**

Feed Rate Average (Tonne/hr): **1.4**

Cost: Capital Cost (US$): **$200,000.00**

Treatment Cost (US$/Tonne): **$20.00 – $30.00** Average Cost (US$/Tonne): **$25.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Air effluent requires treatment prior to discharge (i.e., by carbon, catox, etc.).

Developers:

Jacques Whitford Environment Ltd.
85 Citizen Ct., Unit 18
Markham, ON
Canada L6G1A7
Notes

Contact: Dedhar, Saleem
Phone: (416) 495-8614 Ext:
Fax: (905) 479-9326
Email: sdedhar@noc.tor.hoo

Vendors:

Jacques Whitford Environment Ltd.
85 Citizen Ct., Unit 18
Markham, ON
Canada L6G1A7
Notes

Contact: Dedhar, Saleem
Phone: (416) 495-8614 Ext:
Fax: (905) 479-9326
Email: sdedhar@noc.tor.hoo

Literature References:

Author: **Dedhar, S., Cracknell, J.**
Title: Remediation of Contaminated Soils and Groundwater Using Bioslurping
Journal: Proceedings of World Environmental Congress, London, Ontario, Canada Date: **Sep 1995**

Author: **Dedhar, S., Cracknell, J.**
Title: Remediation of Contaminated Soils and Groundwater Using Bioslurping
Journal: Proceedings of Environment Canada/Gasrep Conference, Toronto, Ontario, Canada Date: **Sep 1995**

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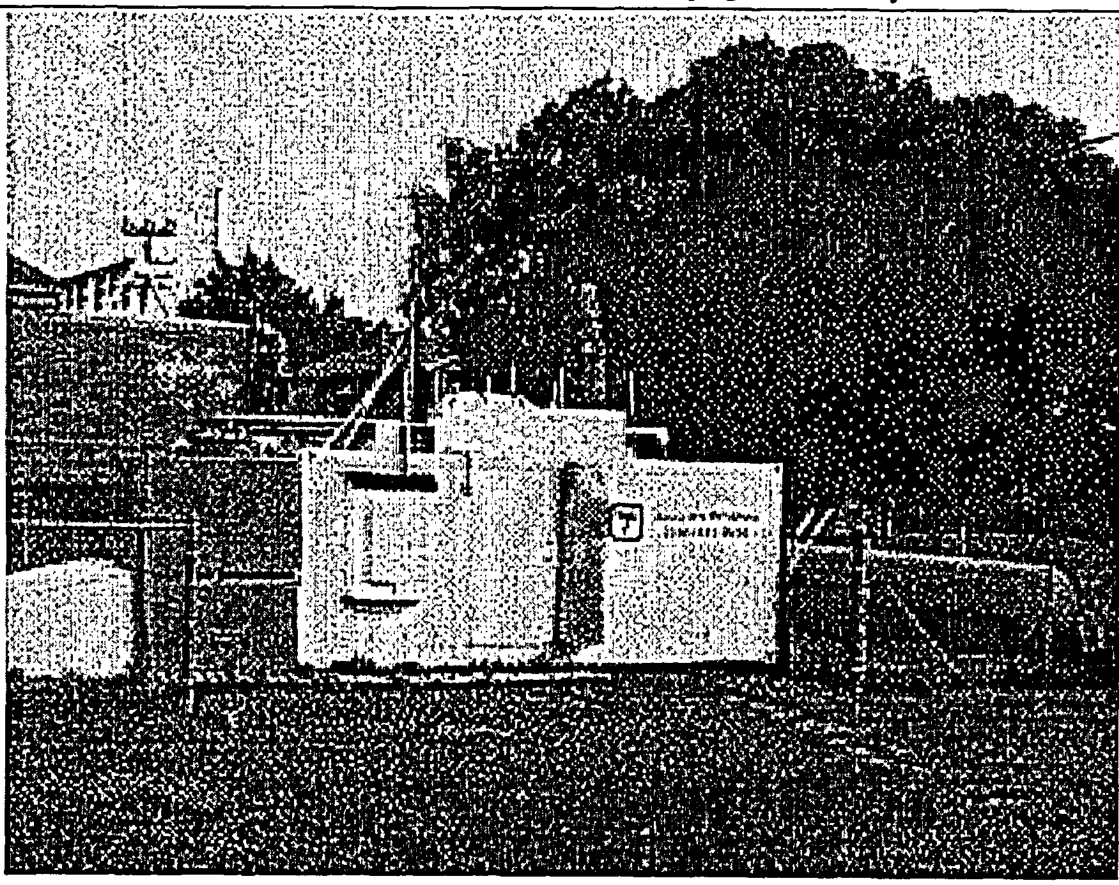
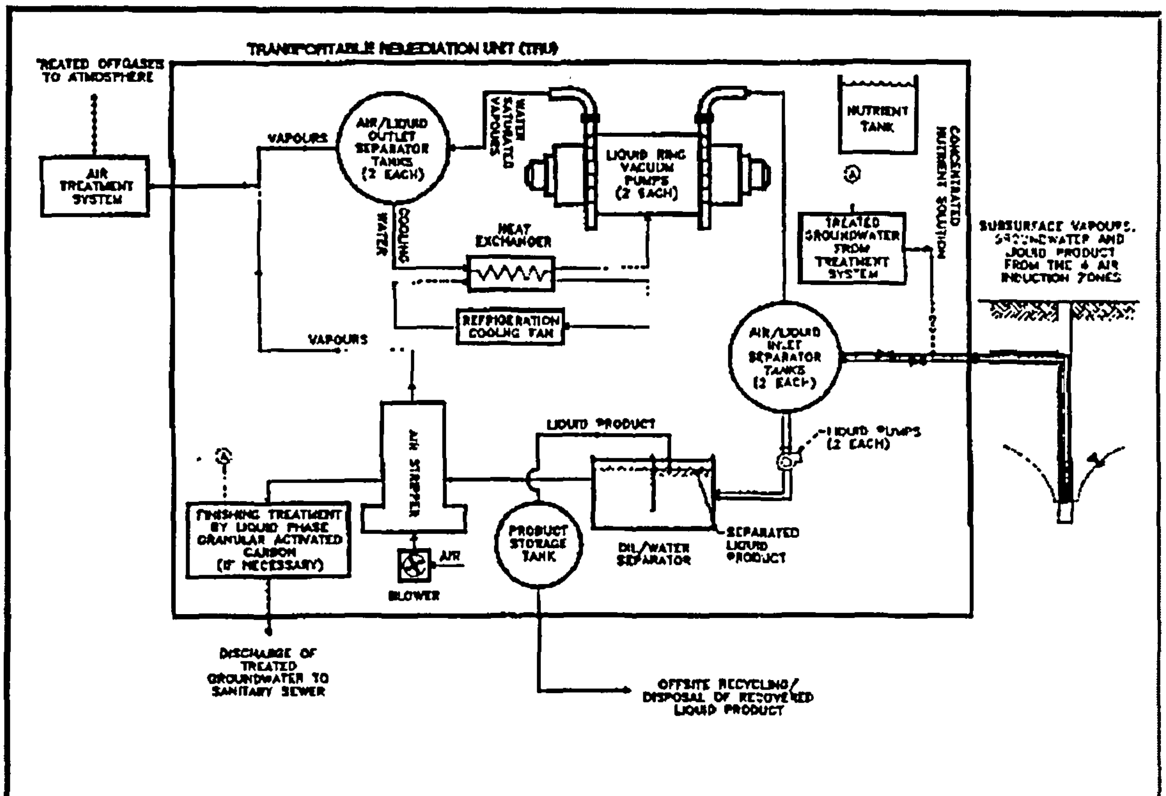
Jacques Whitford Environment Ltd., Bioslurping Treatment System

19-Jan-98





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Jacques Whitford Environment Ltd., Bioslurping Treatment System

19-Jan-98

Project: Former Service Station/Major Roadway Remediation **Year: 94**

Location: Toronto, Ontario, Canada

Full Scale Demo

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): 0.5 Amount Treated (Tonne): 3000

Treatment Cost (US$):

Setup Time (days): 20 Breakdown Time (days): 2

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:
Liquid Hydrocarbons	up to 1000 mm in well	0 mm in well	100
Dissolved BTEX	47 ppm	< 0.2 ppm	>99.5

Cleanup goals: Remove liquid hydrocarbons (gasoline and fuel oil) from water table, amongst buried pipes.

Emissions/ByProducts: Air effluent (156 million m^3) treated using separate thermal/catalytic oxidation system.

Description: A transportable bioslurping system was used to treat liquid hydrocarbons, contaminated groundwater and petroleum vapours for a spill beneath a major roadway in downtown Toronto. The system met remedial objectives after four months of operation, and removed over 8000 kg of contaminants after a total of 8 months.

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Jan de Nul N.V., DJN Dewatering

19-Jan-98

TechID: 52

Technology Type: Pre Treatment, Physical, Soil Washing/Volume Reduction

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

Through use of either the Chamber Filter Presses or the Belt Press dredged sediment can be dewatered to reduce the quantity of material to be treated.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 30

Cost: Capital Cost (US$): $40,000.00

Treatment Cost (US$/Tonne): $70.00 – $140.00 Average Cost (US$/Tonne): $105.00

Cost and capacity depend on water content of the wet sediment.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Waste water.

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

Project: Zuiveringsstation Aalst **Year: 88**

Location: Aalst, Belgium

Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 30 Amount Treated (Tonne): 2500

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Wet sediments.

Contaminants Treated:

Emissions/ByProducts:

Description: Pre-treatment technique for volume reduction.

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Jan de Nul N.V., DJN Elutriator

19-Jan-98

Technology Type: Pre Treatment, Physical, Soil Washing/Volume Reduction

TechID: 53

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Tributyl-Tin, VOCs, Halogenated Organics, BTEX

Separation Technique

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Belgium **Portable:** ☒

Description:

Developed to separate the silt and sand (contaminated and non-contaminated) fractions of dredged sediment, the Elutriator utilizes the flotation technology to accomplish this objective. An upstream of water and air, along with flotation agents carries the silt up and out an overflow. Laboratory tests indicate that there is better separation with this technology than with hydrocyclones.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 300

Cost: Capital Cost (US$): $10,000.00

Treatment Cost (US$/Tonne): $30.00 – $50.00 Average Cost (US$/Tonne): $40.00

For large quantities the unit cost can be reduced.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

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Jan de Nul N.V., DJN Elutriator

19-Jan-98

Project: Slibverwerking Linkeroever

Year: 89

Location: Antwerp, Belgium

Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 300

Amount Treated (Tonne): 2500

Treatment Cost (US$): $100,000.00

Setup Time (days): 5

Breakdown Time (days): 3

Media Treated: Sludges

Contaminants Treated:

Emissions/ByProducts:

Description: Pre-treatment technique for separatiojn sand/silt fraction and oxydation of organic pollutants be means of intensive aeration.

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Jan de Nul N.V., DJN Flotation

19-Jan-98

Technology Type: Chemical, Pre Treatment, Physical TechID: 54

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Tributyl-Tin, Mercury, VOCs, BTEX

Sulphides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

This technology has been designed to clean the sediment in the dredging cycle. As the sediment is dredged, the solids content is adjusted to 10% to 20% and flotation chemicals are added. The chemicals enable the formation of stable films and increase the sediment fines' hydrophobicity. After chemical addition, air flotation is applied and the contaminates associated with the fines concentrate in the foam layer.

The foam layer is skimmed and processed through biological treatment or some other technology.

PAH removal has been good, while heavy metal removal has been moderate.

Limitations:

Efficiency Description: 95% (PAHs)

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 150

Cost: Capital Cost (US$): $20,000.00

Treatment Cost (US$/Tonne): $20.00 – $50.00 Average Cost (US$/Tonne): $40.00

Assuming PAH contamination.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleansed sediment and water, concentrated contaminants.

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
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Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Jan de Nul N.V., DJN Fyto-Sanitation *19-Jan-98*

TechID: 368

Technology Type: Biological, Post Treatment
Fyto-sanitation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Tributyl-Tin, Mercury, Halogenated Organics, BTEX
Sulphides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Belgium **Portable:** ☐

Description:

An afforestation model based on natural succession has been developed as a result of the studies of the bio-physico-chemical and hydrological properties of dredged sludge. The salinat technique is used to bring willow-twigs on the fresh-dredged sludge. In a few months, a tall and very dense wood coverage is established where the contaminating agents are accumulated in the trees and removed from the sludge.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 3 Breakdown Time (days):
Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$): $2,000.00
Treatment Cost (US$/Tonne): $0.00 – Average Cost (US$/Tonne):
Range: $2.00 - $6.00 US/m². Average: $4.00 US/m²

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

Author: **ir. De Vos, Dhr. Cockaerts**
Title: Revalorisation of Dredged Silt by Afforestation
Journal: CATS Congress II Date:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Jan de Nul N.V., DJN Fyto-Sanitation

19-Jan-98

Project: Leie - Menen

Year: 91

Location: Menen, Belgium

Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 30000

Treatment Cost (US$): $20,000.00

Setup Time (days): 3

Breakdown Time (days):

Media Treated: Dredged Sludge

Contaminants Treated:

Emissions/ByProducts:

Description:

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Jan de Nul N.V., DJN Hydrocyclone Separation

19-Jan-98

TechID: 55

Technology Type: Pre Treatment, Physical, Soil Washing/Volume Reduction

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

It is known that most contaminants are associated with the lighter silt fraction of sediment. To minimize the quantity of sediment to be treated, and thus the cost, this contaminated fraction is separated from the dredged sediment.

Hydrocyclones are employed for this pre-treatment while additionally dewatering the contaminated sediment. Parameters that need to be considered for the process to run at an optimal rate include inlet pressure, temperature of water of dredged sediment, the dimensions of inlets and outflow tubes, and the grain distribution of the sediment.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): **4** Breakdown Time (days): **2**

Feed Rate Average (Tonne/hr): **150**

Cost: Capital Cost (US$): **$10,000.00**

Treatment Cost (US$/Tonne): **$30.00 – $50.00** Average Cost (US$/Tonne): **$40.00**

Treatment ex-situ.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
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Vendors:

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Contact: Speleers,
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Fax: 32-53/77.28.55
Email:

Literature References:

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Jan de Nul N.V., DJN Hydrocyclone Separation

19-Jan-98

TechID: 55

Technology Type: Pre Treatment, Physical, Soil Washing/Volume Reduction

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

It is known that most contaminants are associated with the lighter silt fraction of sediment. To minimize the quantity of sediment to be treated, and thus the cost, this contaminated fraction is separated from the dredged sediment.

Hydrocyclones are employed for this pre-treatment while additionally dewatering the contaminated sediment. Parameters that need to be considered for the process to run at an optimal rate include inlet pressure, temperature of water of dredged sediment, the dimensions of inlets and outflow tubes, and the grain distribution of the sediment.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 4 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 150

Cost: Capital Cost (US$): $10,000.00

Treatment Cost (US$/Tonne): $30.00 – $50.00 Average Cost (US$/Tonne): $40.00

Treatment ex-situ.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
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Vendors:

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Contact: Speleers,
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Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Jan de Nul N.V., DJN Pyrolysis

19-Jan-98

Technology Type: Thermal, Post Treatment TechID: 367

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Tributyl-Tin, Mercury, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

Pyrolysis is a thermal treatment process for contaminated soils, sediments or sludges which is very effective to remove a wide range of pollutants. The contaminated material is heated under oxygen-free conditions (i.e. distillation) so that the present contaminating agent is removed through evaporation. In a later condensation step the pollutant (e.g. mineral oil) can be recuperated.

Limitations: No heavy metal removal.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): **3** Breakdown Time (days): **1**

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$): **$140,000.00**

Treatment Cost (US$/Tonne): **$150.00 – $300.00** Average Cost (US$/Tonne): **$225.00**

Cost dependent on water content of the material being treated.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

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Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

Author: **Sorensen**
Title: Mobile and Stationary Process Plants for Separation and Recovery of Oil and Organics from Industrial Waste
Journal: Internal Report Date: **Jun 1989**

Author: **Sorensen**
Title: A Process Plant for Separation and Recovery of Mercury
Journal: Internal Report Date: **Jul 1992**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Jan de Nul N.V., DJN Soil Washing/Flotation

19-Jan-98

TechID: 369

Technology Type: Chemical, Post Treatment, Physical, Soil Washing/Volume Reduction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

In a first phase the contaminated material is mixed intensively with water and detergent. Result is that the pollutant is stripped off from the sandgrain and dissolves in the water/detergent mixture.

In a second phase, the aquades phase of the washing process, the material is cleaned through flotation. The contaminants and detergent will concentrate in the floating foam layer as well as the very fine sludge particles. Both are then skimmed off and further processed.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 15

Cost: Capital Cost (US$): $36,000.00

Treatment Cost (US$/Tonne): $110.00 – $160.00 Average Cost (US$/Tonne): $135.00

Cost is dependent on sand fraction in the treated sediment. The more sand, the cheaper the process can operate.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Waste water, waste sludge fraction.

Developers:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
Belgium 9308 -
Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Vendors:

Jan De Nul N.V.
Tragel 23
Hofstade-Aalst, East-Flanders
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Notes

Contact: Speleers,
Phone: 32-53/731.511 Ext:
Fax: 32-53/77.28.55
Email:

Literature References:

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Jan de Nul N.V., DJN Soil Washing/Flotation

19-Jan-98

Project: RW2 **Year: 94**

Location: Aalst, Belgium Pilot Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): 15 Amount Treated (Tonne): 1000

Treatment Cost (US$): $100,000.00

Setup Time (days): 3 Breakdown Time (days): 2

Media Treated: Sediments; soils

Contaminants Treated:

Contaminant	Untreated:	Treated:	% Removal
Mineral Oil	4500 ug/g	225 ug/g	95

Emissions/ByProducts: Waste water; waste sludge containing pollutants.

Description:

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John A. Kitchen Ltd., Pulse Process

19-Jan-98

TechID: 154

Technology Type: Thermal

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

The proposed technology will use a large rotating drum and pulse combustor to dry sediment and break down the organic contaminants through pyrolysis. The heat of the process is also designed to retain metals in a solid char. As oil and gas are vaporized they will be collected and separated. The gas will be reused to fuel the process limiting emissions to exhaust gases, water vapours, the solid char and reusable oil.

The process is being developed although no tests have been done on sediments, the expected emissions or the quality of the fuels to be recycled. Bench scale tests will occur for the reactions with initial pilot scale tests in a 1055 MJ/hr, 650 kg/hr unit rather than a scaled down model which would be more expensive.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.065

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Char - solids containing heavy metals, water vapour, oil, exhaust gases

Developers:

John A. Kitchen Ltd.
R.R.#3
Hastings, Ontario
Canada K0L1Y0
Notes

Contact: Kitchen, J.A.
Phone: (705) 696-3389 Ext:
Fax: (705) 696-2912
Email:

Vendors:

Novadyne Ltd.
R.R. #3
Hastings, ON
Canada K0L1Y0
Notes

Contact: Buchkowski, A.G.
Phone: (705) 696-3389 Ext:
Fax: (705) 696-2912
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Kenox Wet Air Oxidation

19-Jan-98

TechID: 217

Technology Type: Thermal, Chemical, Pre Treatment

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Mercury, Halogenated Organics, BTEX, Explosives

Sulphides

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The Kenox Wet Air Oxidation (WAO) treatment technology is a continous feed exothermic liquid phase process which operates at temperatures up to 250°C and pressures up to 110 psig. The oxidation reaction is sustained by the injection of oxygen, usually in the form of air. Under these conditions, WAO treats and detoxifies a broad range of organic contaminants or other oxidizable materials present in waste waters. The organic load can be reduced by up to 90% while specific contaminants can be reduced to higher levels up to non-detectable. The technology also facilitates the removal/recovery of heavy metals or catalysts, produces recoverable thermal energy when treating high strength streams and is complimentary to many other pre or post treatment processes, including biological treatment.

Limitations: Ideally, excess suspended minerals, such as silica, should be removed where practical due to potential for causing erosion.

Efficiency Description: Most organic compounds 90% to >99%

Government Funding:

Environmental Concerns: Effluent usually requires polishing, off-gas may require scrubbing.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $12.50

This process usually costed per liter.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Spent air, CO2, Non Condensible Volatiles.

Developers:

Kenox Corporation
53 Village Centre Place, Suite 300
Mississauga, Ontario
Canada L4Z 1V9
Notes

Contact: Stott, Brad
Phone: (905) 275-3798 Ext:
Fax: (905) 275-8246
Email:

Vendors:

Raytheon Engineers and Constructors
Binckhorstlaan 117, P.O.B. 91
The Hague,
The Netherlands 2501 AK
Notes

Contact: van Vliet, J.(Hans) W.
Phone: 01131703493940 Ext:
Fax: 01131703494256
Email:

Leigh Environmental Ltd. (U.K.)
1 Station Road, Four Ashes
Wolverhampton,
United Kingdom WV10 7DQ
Notes

Contact: Howard, P.
Phone: 44-902-790-011 Ext:
Fax: 44-902-791-711
Email:

Literature References:

Author: **Evans, D.W., Solaimani, H.M., Garamszeghy, M., Stott, J.B.**
Title: Chemical Oxidation, Technology for the Nineties
Journal: International Chemical Oxidation Association Date: Feb 1995

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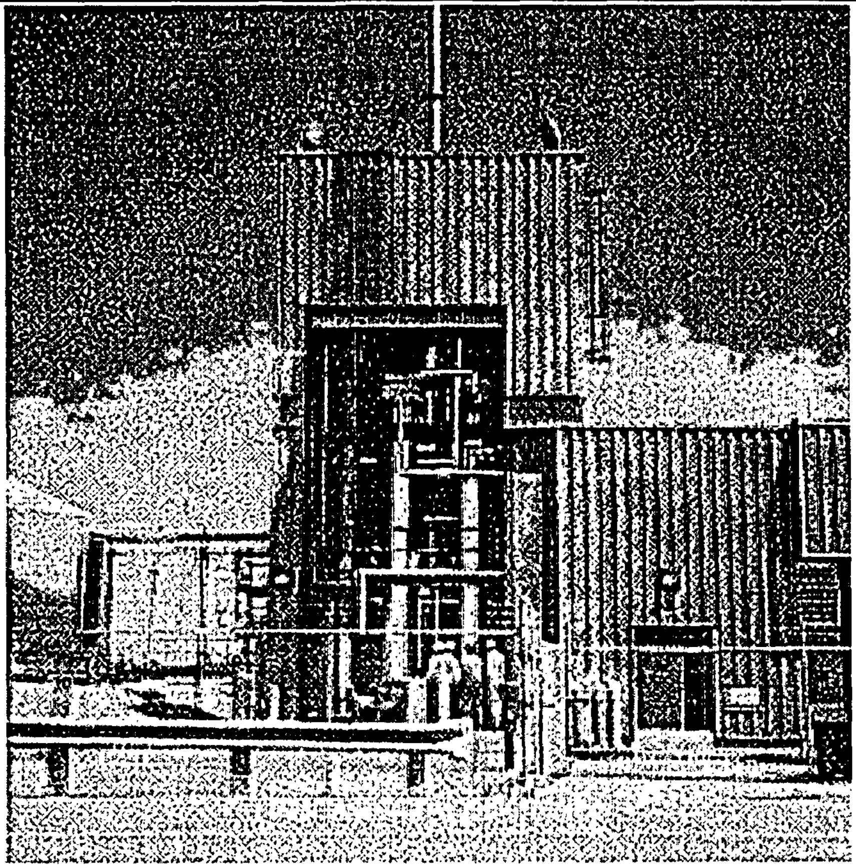
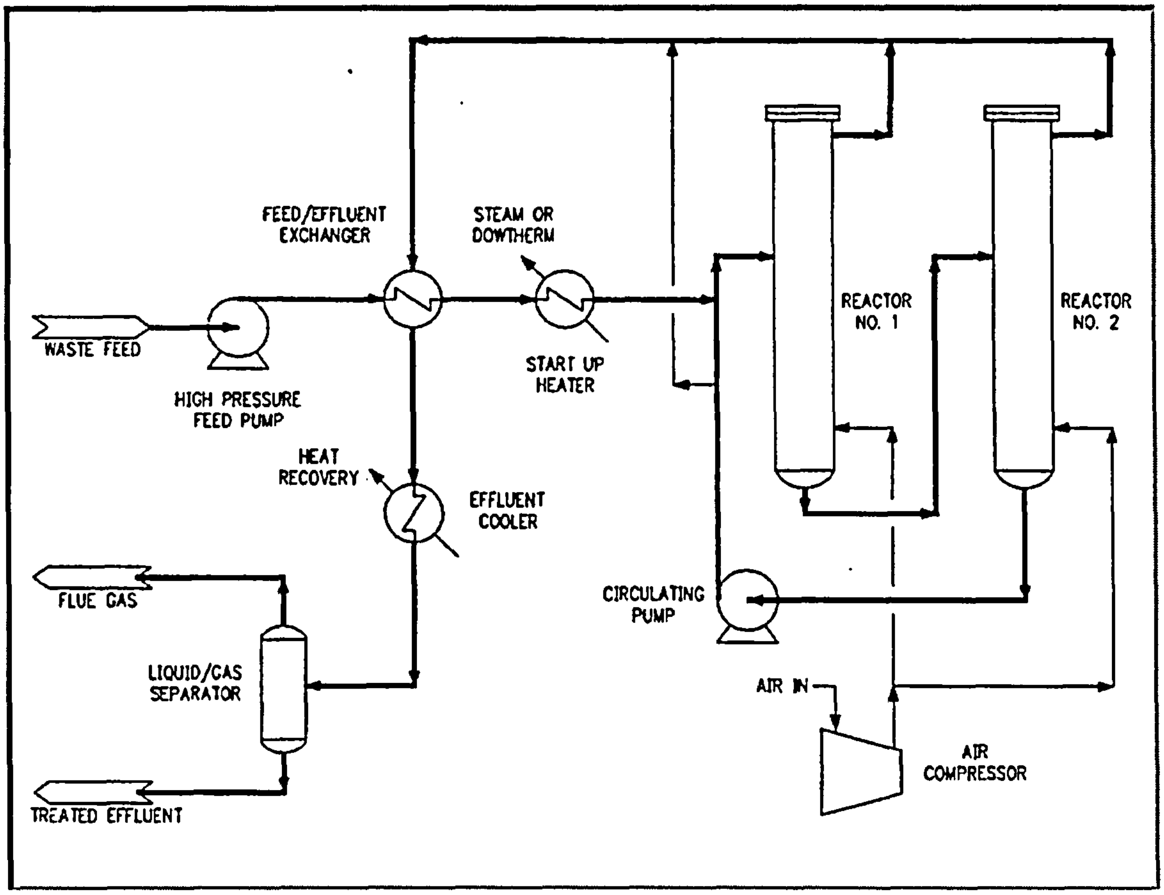
Kenox Wet Air Oxidation





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Klohn-Crippen, ChemTech Soil Treatment Process

19-Jan-98

TechID: 318

Technology Type: Chemical, Metal Extraction, Post Treatment, Physical, Soil Washing/Volume Reduction

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The ChemTech soil segregation process uses the turbulent mixing of a continuously fed three phase fluidized bed with the chemistry of an air flotation system to separate the feed soil into coarse (clean) and fine (contaminated) fractions. The effectiveness of the step has been verified at both bench and pilot scales using a number of industrially contaminated soils. The rationale behind this step is that absorbed contaminants preferentially collect into the fine clay and organic soil fraction because of the large surface area to mass ratio. This step allows for a significant reduction in the cost of the process; reduction exceeding 90% of the volume of soil to be extracted have been achieved by segregating the soils. The effectiveness of the fluidized bed system used in this step is such that the coarse fraction contains few residual fines and does not require further treatment. Competing soil treatment technologies often use a mechanical size separation step, such as grizzly separators. The ChemTech fluidized bed process is unique in its ability to vary the nature of the retained fraction by altering the operating regime of the fluidized bed.

Limitations: Performance is dependent upon both the site and the contaminants.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 1 Breakdown Time (days): 1

Feed Rate Average (Tonne/hr): 15

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): $20.00 – $30.00 Average Cost (US$/Tonne): $25.00

Capital cost is based on 1,000 tonnes/day treatment capacity.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solids and water. Solids -- fine fractions (concentrated and contaminated). Water -- wash water containing foaming agents.

Developers:

ChemTech Analysis Inc.
10200 Shellbridge Way
Richmond, B.C.
Canada V6X2W7
Notes

Contact: Stephenson, Rob
Phone: (604) 273-0311 Ext:
Fax: (604) 279-4300
Email: stephenr@rmd.klohn

Vendors:

ChemTech Analysis Inc.
10200 Shellbridge Way
Richmond, B.C.
Canada V6X2W7
Notes

Contact: Stephenson, Rob
Phone: (604) 273-0311 Ext:
Fax: (604) 279-4300
Email: stephenr@rmd.klohn

Literature References:

Author: **Stephenson, R.J., Nelson, J.C., McBroom, L.L., Yan, V.**
Title: Soil Washing for Remediation of Heavy Metals Contaminated Soils
Journal: 19th Annual Mine Reclamation Symposium - British Columbia, Canada Date: **Jun 1995**

Author: **Stephenson, R.J., Nelson, J.C., Lim, C.J., Lim, K.S.**
Title: Mobile Soil Treatment Apparatus and Method, 08/527,750
Journal: United States Patent Application Date: **Sep 1995**

Author: **Stephenson, R.J., Nelson, J.C., McBroom, L.L., Yan, V.**
Title: Metals Removal from Contaminated Soil and Sediments
Journal: 5th Annual Symposium on Groundwater and Soil Remediation Date: **Oct 1995**

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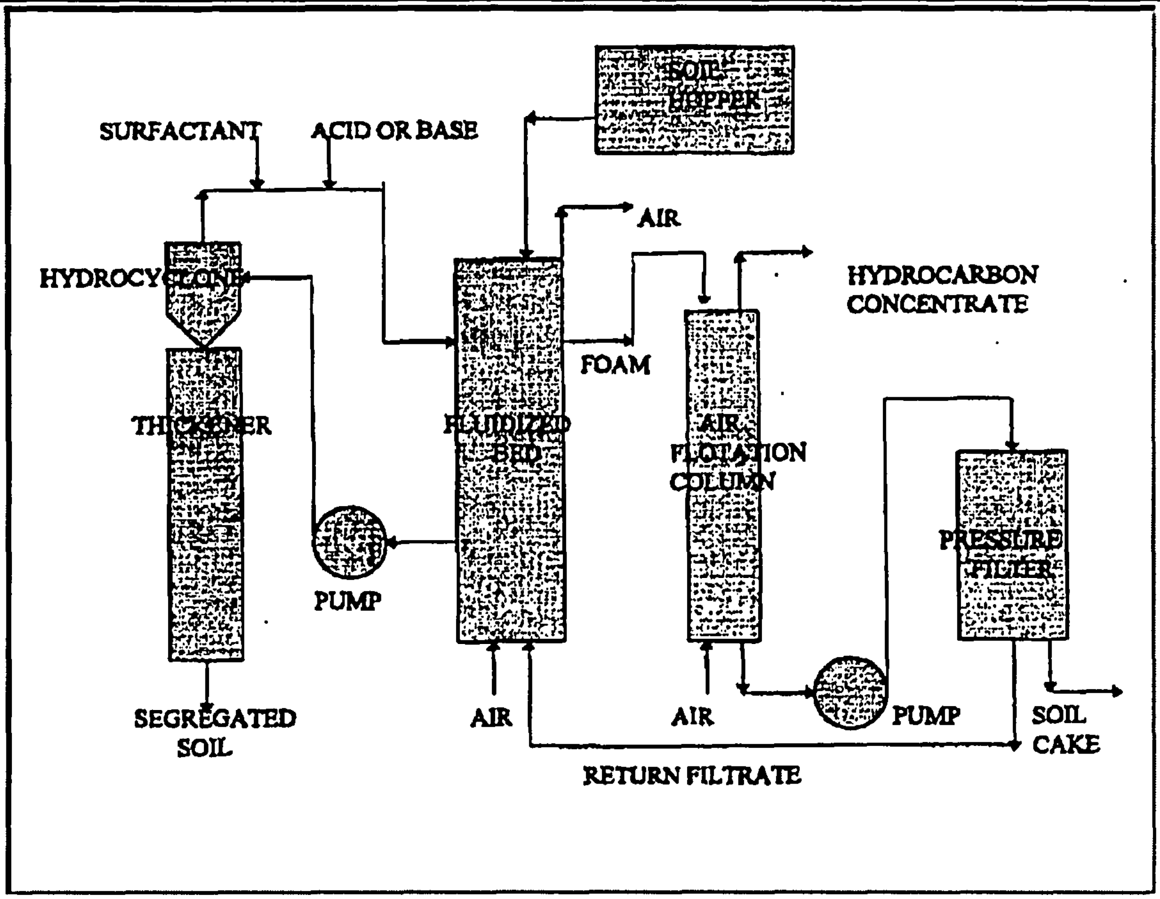
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Klohn-Crippen, ChemTech Soil Treatment Process

19-Jan-98



Project: Preliminary Tests **Year: 95**

Location: , British Columbia, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 1 Breakdown Time (days): 1

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal:
Diesel	41,000 ug/g	170 ug/g	99.6
Motor Oil	161,400 ug/g	1950 ug/g	98.8
Lead	176 ug/g	20 ug/g	88.6
Arsenic	27 ug/g	8 ug/g	70.4

Emissions/ByProducts:

Description: The performance of the soil treatment process varies with the soil composition and the concentration and type of contaminants in the soil. The results are from some preliminary testing which was performed for a confidential client.

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Lupien, Rosenberg Consultants Inc., Electronic Removal of Heavy Metals

20-Jan-98

TechID: 307

Technology Type: Electrokinetic

Ex-Situ treatment is more suitable for our electro-kinetic technology.

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The method is based on electrokinetical phenomena, which occur when the soil is electrically charged with direct current by means of electrodes inserted in the ground. The most important phenomena involved are the induced pore solution displacement (electroosmosis) and the migration of ions and ion-complexes within the soil moisture (electrolysis). During the treatment, an acid front develops at the anode, increasing desorption and solubility of heavy metals, and promoting their transport by ionic migration and/or pore solution displacement. Contaminants are extracted even as solids plated on the cathode, or by the treatment of the effluent solution.

The effectiveness of the process depends on the mobility of the contaminants, which is related to their concentration and the form under which they are present. Mobility of heavy metals is also tied to the nature of the soils, namely the grain size distribution, cation exchange capacity, buffering capacity, pH and organic content. In order to have a successfull treatment, a chemical control of the process is of prime importance.

The cost-effectiveness of electrokinetic decontamination of industrially contaminated soils have been demonstrated in 1 liter and 100 liter cells. The removal of As, Cd, Cr, Cu, Ni, Pb, and Zn have been successfully done on many different types of soils. Up to 95% removal has been reached in some cases. For samples contaminated at a level 2-3 times MEF level C, we presently calculate a cost of about $100/m³.

In order to assess the effectiveness of the treatment and choose the best recipe in a particular case, standardized 2 weeks small scale tests are done in our laboratories.

We are currently involved in the execution of a pilot scale test (6 m³). This test should be completed by December 1995.

Limitations: A wide range of soils can be successfully treated, but the principal limitations for a cost-effective treatment are the following - Soils with very high buffering capacity; Insoluble forms of contaminant; Very high level of contamination (around 100,000 ppm); Contamination due to coarse metallic chunks; Contamination included in a vitreous matrix.
The two last restrictions can easily be solved by separation with standard mining technologies.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns: Use of corrosive chemicals, production of a concentrated contaminated sludge to be treated/disposed.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 10 Breakdown Time (days): 50

Feed Rate Average (Tonne/hr): 1

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $190.00

Contaminant: Zinc. Initial level: 15,000 ug/g dry. Final level: 1,500 ug/g dry. Total amount treated: 10,000 tonnes (assumed). Other assumptions: 400 m³ batch installation, 5 batches/year, total treatment time 3 years, disposition of concentrated sludge for $500/m³. We have done 21 laboratory experiments on 1 to 100 liter cells, and are constructing a pilot scale test of 6 m³.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Approximately 5% concentrated sludge.

Developers:

Lupien, Rosenberg Consultants Inc.
1869, 32nd Avenue
Lachine, PQ
Canada H8T3J1
Notes

Contact: Rosenberg, Peter
Phone: (514) 631-1869 Ext:
Fax: (514) 631-8966
Email:

Vendors:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Lupien, Rosenberg Consultants Inc., Electronic Removal of Heavy Metals

20-Jan-98

SERRENER
855, rue Pepin
Sherbrooke, PQ
Canada J1L2P8

Contact: Viel, Guy
Phone: (819) 829-0101 Ext:
Fax: (819) 829-2717
Email:

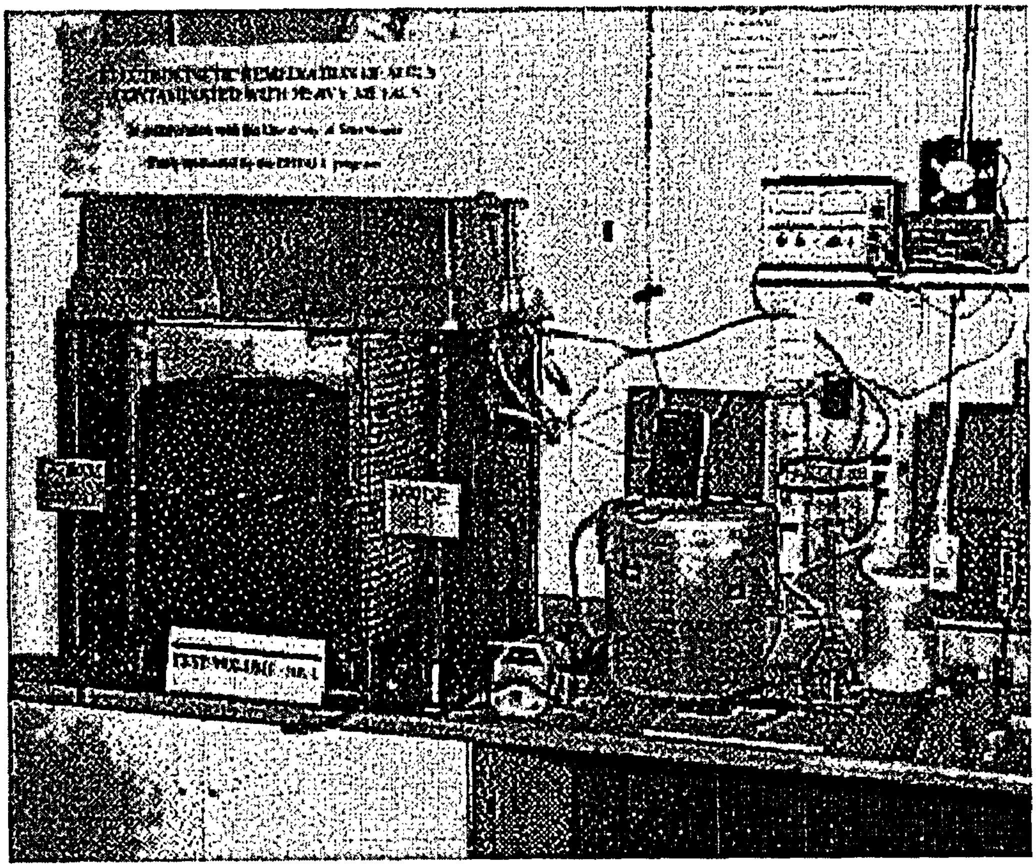
Notes

Literature References:

Author: **Cthier, Y.A.**
Title: Migration du plomb dans une argile par electrocinetique
Journal: Thesis, Master Degree in Geotechnical Eng., Sherbrooke Univ., Quebec. Date: **Jan 1993**

Author: **Lefebvre, G., Couture, C., Pavate, T.V.**
Title: Efficacité comparative de l'électro-osmose et d'un simple lessivage pour le traitement de sables silteux naturels contaminés au plomb.
Journal: 1993 Joint CSCE-ASCE National Conf. on Env. Eng., Montreal, Canada. Date: **Jan 1993**

Author: **Lefebvre, G., Burnotte, F., Rosenberg, P.**
Title: Controle electrocinetique des ecoulements souterrains
Journal: First International Congress on Env. Geotechnics, Edmonton, Alberta Date: **Jan 1994**



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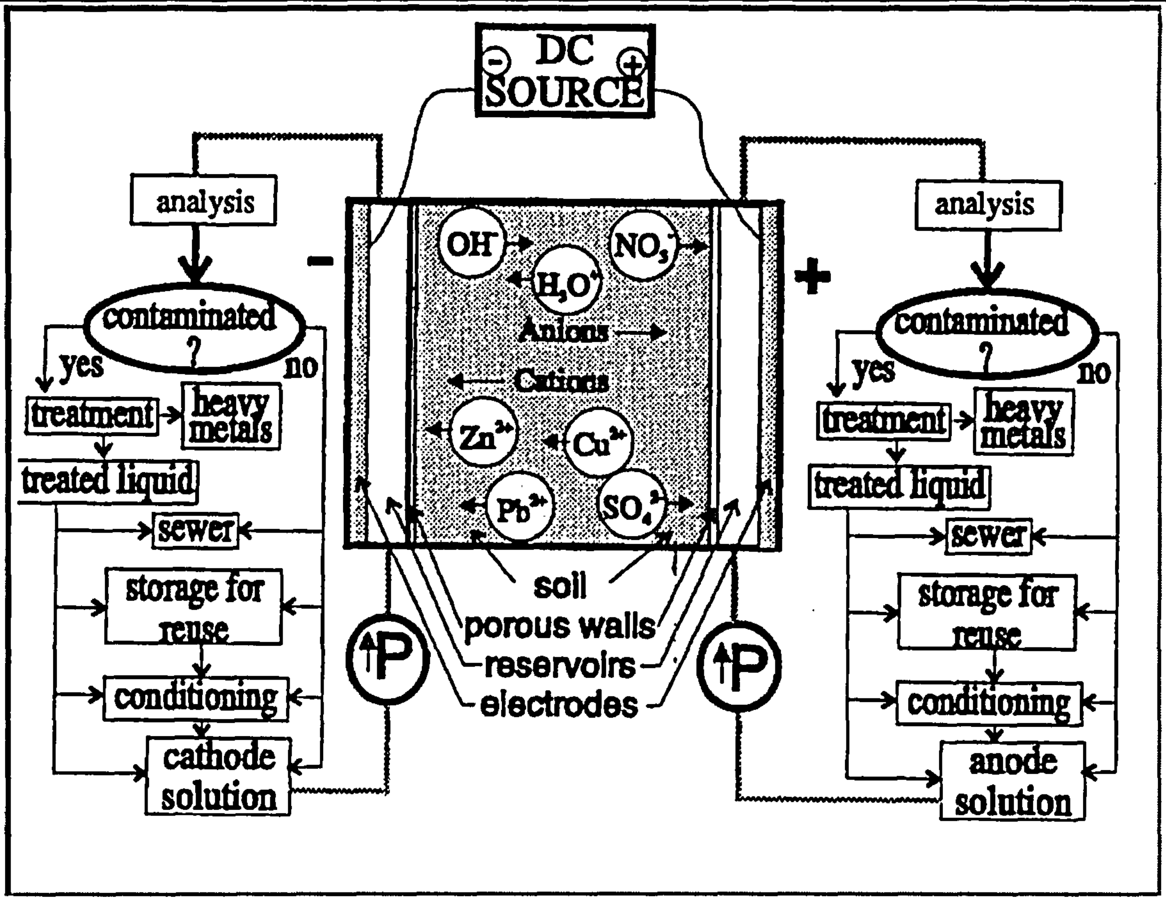
Lupien, Rosenberg Consultants Inc., Electronic Removal of Heavy Metals *20-Jan-98*



Project: Electrokinetic Decontamination of Soils **Year:** 93

Location: Lachine, Quebec Bench Scale

Client/Funding Agency	Contact	Phone
DESRT	Martine Audet Lapointe	(514) 283-9553

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Zn, Pb, Cd, Cr.

Emissions/ByProducts:

Description: Laboratory set up of 1 liter plexiglass cell. 21 such experiments have been conducted on different industrially contaminated soils in 1 and 100 liter cells. Setup time 5 days. Breakdown time 20 days.

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Micro-Bac International Inc., Bioremediation

20-Jan-98

Technology Type: Biological

TechID: 304

Contaminants Treated: PAH's, PCB's, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Explosives

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Micro-Bac International Inc. isolates and manufactures natural, biological products to augment in situ or ex situ bioremediation of sludge lagoons, landfarming, pump and treat systems, bioreactors, soil washing, waste minimization, and tank cleaning. Micro-Bac's Laboratories provide extensive R & D and analytical services including bacterial analysis, treatability tests, and biodegradation studies. No genetic engineering has been used in the development process of the bacterial products, and there are no spores, slime-formers, or algae involved.

Micro-Bac is a 14 year old biological research and development and manufacturing company. Micro-Bac's products have been used in Canada since the early 1980's. A major asset of Micro-Bac is comprehensive manufacturing control. All Micro-Bac products are manufactured in the compnay's own facilities under strict quality control guidelines. Micro-Bac's reesearch and development laboratories continually produce specialized products as new bioremediation needs are defined.

Limitations: Certain types and levels of heavy metals can be detrimental to the biological process, as can some other microbial inhibitors such as pH, extreme temperatures, and permeability/porosity of the soil.

Efficiency Description:

Government Funding:

Environmental Concerns: None

Health & Safety Plan Available: ☐

Regulatory Approvals Meets accepted EPA criteria for biological products that are released into the environment.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Varies greatly on project.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Carbon Dioxide

Developers:

Micro-Bac International Inc.
3200 N. IH 35
Round Rock, Texas
USA 78681-2410
Notes

Contact: Osborn Coon, Marilyn
Phone: (512) 310-9000 Ext:
Fax: (512) 310-8800
Email:

Literature References:

Author: **Schneider, D.R., Billingsley, R.J.**
Title: Bioremediation of Organic Wastes
Journal: Pudvan Publishing Co., Inc. Date: **Jan 1990**

Author: **Schneider, D.R.**
Title: Bioremediation of Organic Wastes
Journal: Haztech Canada '90 Calgary, Alberta Date: **Nov 1990**

Author: **Schneider, D.R**
Title: Critical Parameters for Determining Suitability for Bioremediation
Journal: Haztech Canada '91 Toronto, Ontario Date: **Jun 1991**

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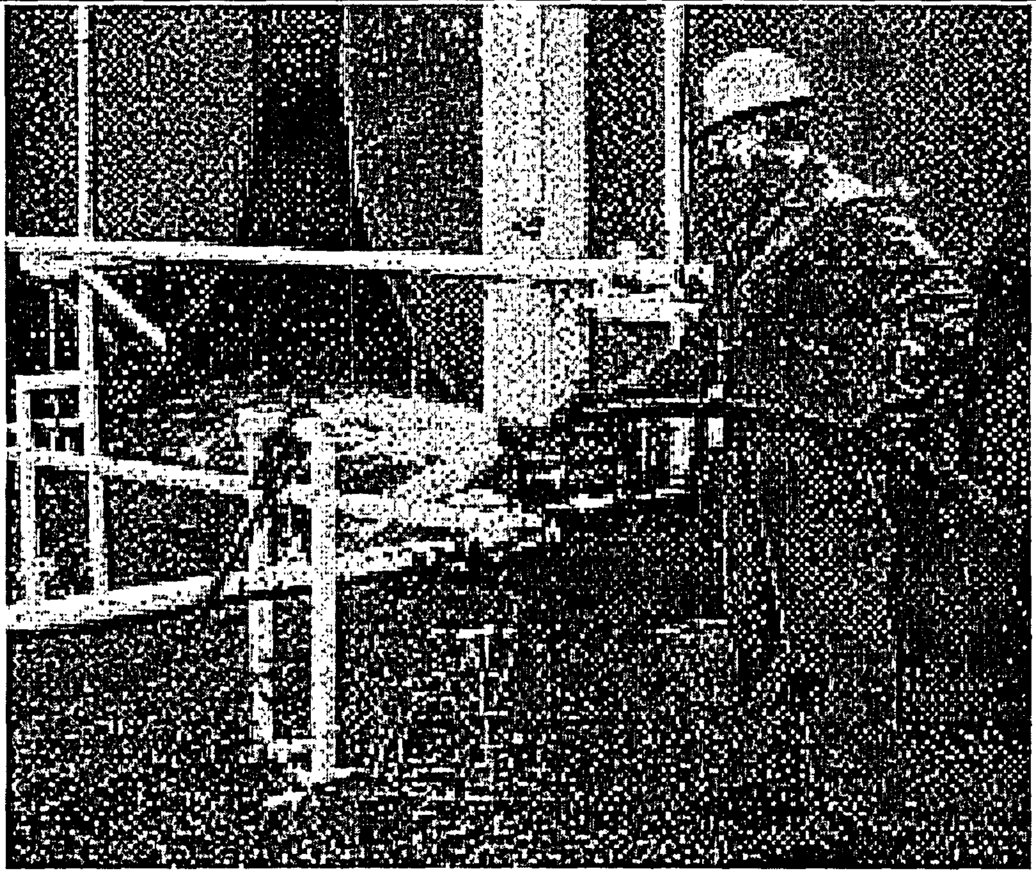
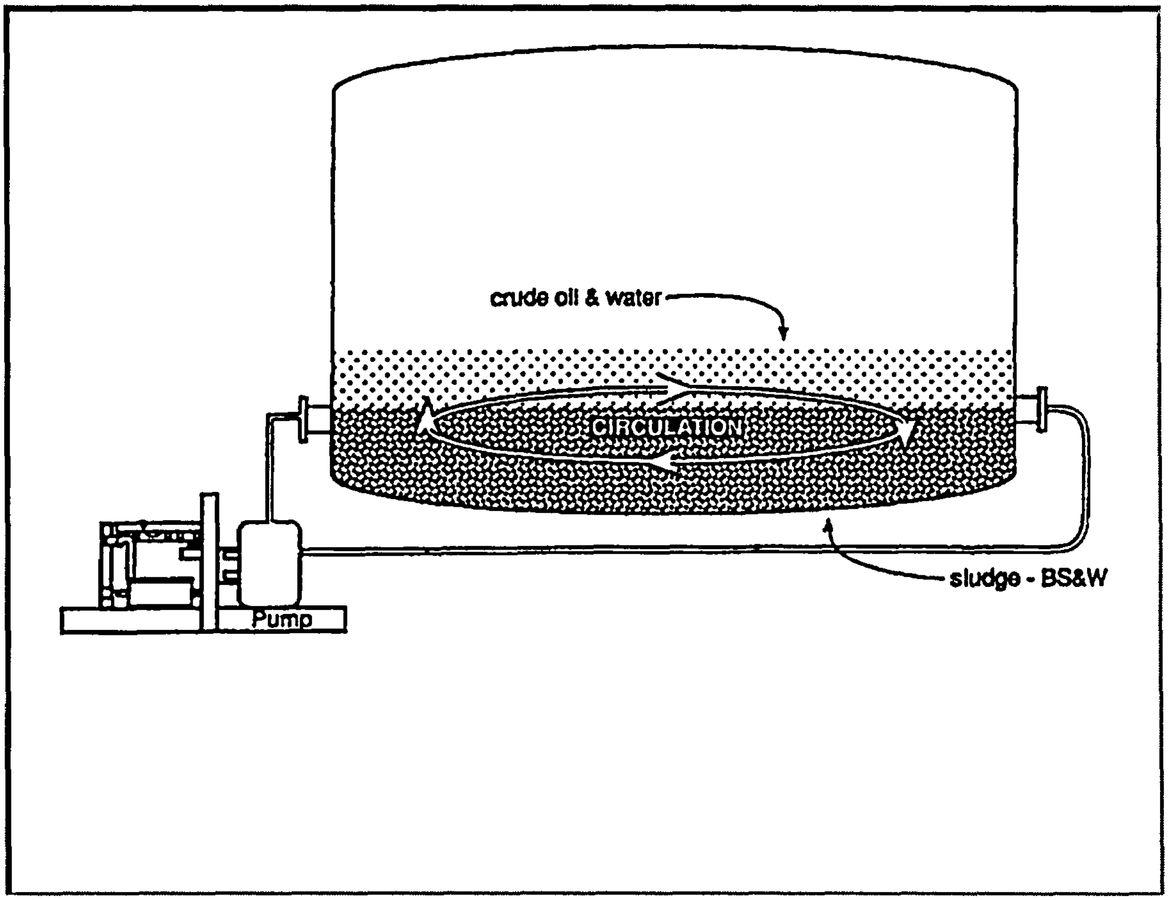
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation





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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Micro-Bac International Inc., Bioremediation *20-Jan-98*

Project: Real Estate Transaction-Confidential **Year: 93**

Location: Massachusetts Full Scale Demo

Client/Funding Agency	Contact	Phone
Private		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Kerosene, BTEX

Emissions/ByProducts:

Description: Amount treated : 9,000 tonnes. Treatment cost $40.00/cubic yard. Applied by spraying onto wet land and injecting into sediments. Closure was risk based on a site specfic clean-up goal. Set-up time: 5 days.

Project: Manufacturing Company **Year: 93**

Location: Pennsylvania Full Scale Demo

Client/Funding Agency	Contact	Phone
Private		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: No. 6 fuel oil.

Emissions/ByProducts:

Description: Amount treated: 975 tonnes.Treatment cost: $25.00/cubic yard. Set up three landfarm cells, spread the dirt to 12" thick, sprayed on bacteria and nutrients, and mixed with drilling equipment. Monitored for nutrient levels, TPH and for moisture. Once tested clean, soil was used on site for fill.

Project: Diesel Generating Station **Year:**

Location: Canada Full Scale Demo

Client/Funding Agency	Contact	Phone
Private		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Diesel fuel C-10-C20

Emissions/ByProducts:

Description: Amount treated: 1,500 tonnes.Treatment cost: $84,600 total. Diesel generating station supplying power to northern Canadian community. An undergrond transfer pipeline had broken between the fuel plane unloading station and the tank farm.

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MK Thermal Treatment Units

20-Jan-98

TechID: 126

Technology Type: Incineration

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☐

Description:

MK possess two types of incineration units:

The Thermal Oxidation Unit (TOU) is a fluidized bed incinerator with a 33 000 tons per year capacity. The unit consists of one 12-million-watt thermal oxidation unit with dry offgas scrubbing and particulate collection. All ash is suitable for on-site landfill.

The Thermal Destruction Unit (TDU) is designed for the incineration of drums of waste. The system was designed for destruction and removal efficiencies of 99.9999% for dioxins and 99.99% for all other principal organic hazardous constituents.

Limitations:

Efficiency Description: See technology description

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Ash and treated off-gases.

Developers:

Morrison Knudsen Corp.
P.O.Box 73
Boise, ID
USA 83729-
Notes

Contact: Hartley, R. Mac
Phone: (208) 386-5000 Ext:
Fax: (208) 386-6658
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

MRS Modular Vapor Extraction Systems (VES)

20-Jan-98

TechID: 134

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The modular sytems available are designed for the treatment of soils and groundwater. These capabilities indicate that sediment treatment may also be possible. The modules provide air flows of 0 to 850 cfm and vacuum from 0 to 15" Hg.

The technology is designed for compatibility with NPT standard fittings for connection to extraction and emission equipment.

Modular Remediation Services can provide treatment for the contaminated gases through a thermal oxidizer module or carbon adsorption system.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Modular Remediation Systems Inc.
26127 West Route 113
Coal City, IL
USA 60416-

Contact: Smith, J.J.
Phone: (815) 458-3895 Ext:
Fax:
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Natural Environment Recovery Inc., Ex-Situ Bioreactors

20-Jan-98

TechID: 305

Technology Type: Biological

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

This mobile, ex-situ bioremediation technology incorporates NER's proprietary aerobic bioremediation process into a transportable system. These bioreactors can be loaded using conventional excavation equipment. Designed for on-site treatment, they are equipped with fluid distribution systems that transport nutrients and microbes through even fine grained soils. Project demonstration results include the remediation of soils containing over 8000 ppm TPH and 5300 ppm total PAH to parkland/residential guidelines of less than 100 ppm TPH and less than 10 ppm total PAH. Results also include remediation of soils with hydraulic conductivity values (kf) as low as 1.5 x 10(-7) cm/s.

Limitations: Each bioreactor treats 60m³ per batch. Larger batch volumes require multiple bioreactors.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals MOEE.
Waste Disposal Site (Processing) CoFA #A680036.
Waste Disposal Site (Air) CoFA #8-3067-94-006.

Setup/Feed: Setup Time (days): 7 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $30.00

(Feed Rate: 15 tonne per reactor). Contaminant: PAH (chrysene). Initial level: 350 ug/g dry. Final level: <0.01 (non-det.). Total amount of mat. treated: 10,000 tonnes. Cost quotation does not include excessive material handling costs for excavation, pumping, dredging of sediments.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Natural Environment Recovery Inc.
100 York Blvd., Suite 500
Richmond Hill, Ontario
Canada L4B1J8
Notes

Contact: Itamunoala, Godknows
Phone: (905) 881-6011 Ext:
Fax: (905) 881-6015
Email:

Vendors:

Natural Environment Recovery Inc.
100 York Blvd., Suite 500
Richmond Hill, Ontario
Canada L4B1J8
Notes

Contact: Itamunoala, Godknows
Phone: (905) 881-6011 Ext:
Fax: (905) 881-6015
Email:

Natural Environment Recovery Inc., Atlantic Division
100 New Gowen St., Suite 790, Cabot Place
St. John's, Nfld.
Canada A1C6K3
Notes This vendor serves Atlantic region.

Contact: Cahill, Moya
Phone: (709) 754-1874 Ext:
Fax: (709) 754-4704
Email:

Literature References:

Author: **Lee, N.**
Title: Application of a Mobile Ex-Situ Bioreactor Technology to the Remediation of Hydrocarbon Contaminated Soil.
Journal: DESRT Technical Summary Sheet Date: **Mar 1995**

Author: **Lee, N., Itamunoala, G.F., Chrzanowska, K.C.**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Natural Environment Recovery Inc., Ex-Situ Bioreactors

20-Jan-98

Title: Biostimulant in an Improved Fluid Distribution System to Increase Effectiveness of an Ex-Situ Bioremediation Process

Journal: Proceedings of the 5th Annual Symposium on Groundwater and Soil Remediation Date: Oct 1995

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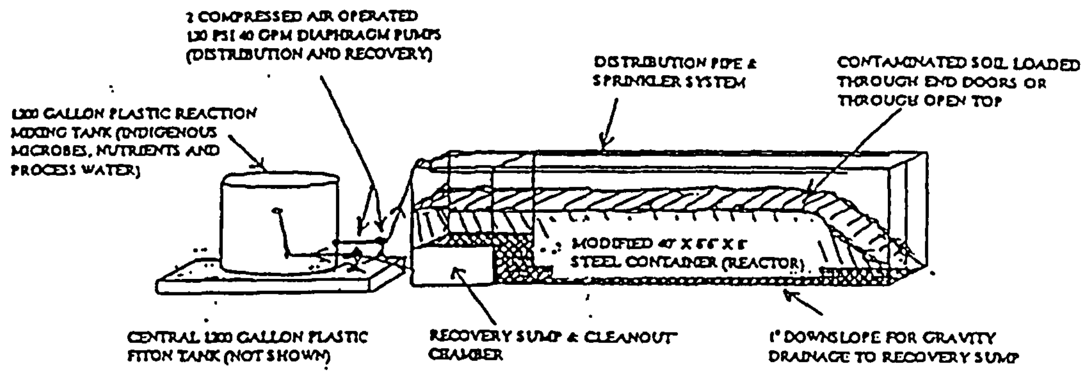
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Natural Environment Recovery Inc., Ex-Situ Bioreactors

20-Jan-98



Project: Metro Toronto Region Conservation Authority Land — **Year: 94**

Location: East York, Ontario — Commercial

Client/Funding Agency	Contact	Phone
DESRT / MTRCA	Ed Rodrigues / Brian Dundas	(416)314-4197/ (416)392-9725

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated:

Contaminants Treated: TPH, Ethylbenzene, Xylene, PAH (Chrysene, e.g.)

Emissions/ByProducts:

Description: Site was formerly Domtar Don Valley Mill and Polyresins Inc. manufacturing plant. Bioreactors are modified marine shipping containers equiped with distribution and drainage systems for bioremediation equipment.

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NBM Aannemingsbedrijf Indirect Thermal Desorption

20-Jan-98

Technology Type: Thermal

TechID: 109

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☐

Description:

Full scale operations of thermal destruction are available with rotating kiln or other technologies.

Limitations:

Efficiency Description: 100%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$90.00 – $110.00** Average Cost (US$/Tonne): **$100.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Sulfur dioxide, carbon dioxide and NOx

Developers:

NBM Aannemingsbedrijf b.v.
Zonweg 33, P.O. Box 16032
The Hague, 2500 BA
The Netherlands 2500 -
Notes

Contact:
Phone: 011703834013 Ext:
Fax:
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

NBM Bodemsanering Indirectly-Heated Thermal Desorption

20-Jan-98

TechID: 110

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

The Indirectly-Heated Thermal Desorption process has been operating commercially in The Netherlands since 1987. Tests with hydrocarbons and chlorinated organics yielded soil effluent concentrations below the detection limits, independent of the initial contaminant concentrations.

Soil input to the process is screened for oversize material prior to entering an externally heated rotary drum drier. The soil and gas exiting this unit are separated and the soil fed to a gastight, externally heated rotary tube furnace in which an oxygen free environment is maintained. The soil in the furnace is heated to 400-650 deg. Celsius. Clean soil and gas exiting this unit are separated.

The gas stream from the predrier consists of water vapour, air and volatile organic vapours. The gas stream from the furnace consists of contaminant vapours, pyrolysis products, water vapour, inert gases. The two gas streams are passed through ceramic filters to remove particulates. The predried stream may be condensed or incinerated, while the furnace stream is incinerated (at 1100-1200 deg. Celsius). The incinerator exhaust gases are recycled to heat the pre-drier prior to scrubbing and release to the atmosphere.

Limitations:

Efficiency Description: Independent of initial soil concentrations, below detection limit

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Process meets all regulatory requirements in The Netherlands

Setup/Feed: Setup Time (days): 60 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 15

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $60.00 – $110.00 Average Cost (US$/Tonne): $85.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Incinerator off-gases, clean soil

Developers:

NBM Bodemsanering B.V.

,
The Netherlands
Notes

Contact: Put, B.
Phone: (604) 988-6669 Ext:
Fax: (604) 988-6669
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

NBM Bodemsanering Soil Washing Process - Metals and Hydrocarbons

20-Jan-98

TechID: 190

Technology Type: Post Treatment, Pre Treatment

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

Heavy metals tend to adhere to the small (sub- 60 micron) mineral particles of sediment and PAH laden particles tend to be light organics. By using a combination of hydrocyclones to remove heavy metals from the bulk sand sized material and a counter flow flotation system to separate sand and PAH tarry material a relatively clean sand fraction can be generated. In addition two distinct contaminated fractions may be generated requiring further treatment.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Process meets all regulatory requirements currently in effect in The Netherlands

Setup/Feed: Setup Time (days): 20 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 100

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $20.00 – $30.00 Average Cost (US$/Tonne): $25.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

NBM Bodemsanering B.V.

,

The Netherlands

Notes

Contact: Put, B.
Phone: (604) 988-6669 Ext:
Fax: (604) 988-6669
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

NRCC Adsorption Approach

20-Jan-98

TechID: 138

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The NRC coal agglomeration process, which has been commercialized at the 30 to 40 tph solids level (approx. 600 gpm aqueous slurry flow) can also be applied to the removal of organics from contaminated soils and sediment.

For the treatment of soil and sediment, added adsorbents such as coal or shredded rubber tires scavange the contaminating organics which become the agglomerating agent for the added fine adsorbents. Products of the process are then the agglomerated adsorbent, the cleaned soil or sediment, and recycled water. The agglomerated adsorbent may be suitable as a fuel in off-site applications.

Alternatively in the case of hazardous organics coating the adsorbents, the process might be used as a preconcentrating step prior to incineration of the organic containing agglomerates.

For a sediment remediation application, bench scale testing will be required to determine appropriate operational parameters.

Limitations:

Efficiency Description: >95% organic separation

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.0625

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $3.00 – $6.00 Average Cost (US$/Tonne): $4.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleaned sediment/soil, agglomerated adsorbent, and recycled water.

Developers:

National Research Council of Canada
Montreal Road Campus, Building M-12
Ottawa, Ontario
Canada K1A0R6
Notes

Contact: Sparks, Bryan D.
Phone: (613) 990-1769 Ext:
Fax: (613) 941-2529
Email: Bryan.Sparks@NRC.

National Research Council of Canada
Montreal Road Campus
Ottawa, Ontario
Canada K1A 0R6
Notes

Contact: Capes, C.E.
Phone: (613) 993-2455 Ext:
Fax: (613) 952-1275
Email:

Vendors:

National Research Council of Canada
Montreal Road Campus, Building M-12
Ottawa, Ontario
Canada K1A0R6
Notes

Contact: Sparks, Bryan D.
Phone: (613) 990-1769 Ext:
Fax: (613) 941-2529
Email: Bryan.Sparks@NRC.

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

NRCC Solvent Extraction Soil Remediation (SESR)

20-Jan-98

Technology Type: Metal Extraction, Organic Extraction

TechID: 175

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Process involves concurrent solvent extraction and agglomeration of fine textured soil. Solvent and extraction conditions (pH, time, temperature, etc.) can be adjusted to suit particular contaminants. If soil contains leachable heavy metals these can be fixed so that it meets EPA TCLP at pH 2.9. Solvent is recovered for recycle to leave a contaminant concentrate for final disposal. Cleaned soil may be amended to allow for replacement as topsoil if appropriate. Plant growth tests have shown that agglomerated, cleaned soil will perform as well as uncontaminated soil.

Tests have been conducted successfully, at the laboratory scale, for the following contaminants: heavy oil, diesel, chlorinated phenols, PCB's. Promising results have been obtained with some herbicides and pesticides. Lead fixation has been proven in many tests.

Limitations: Process is water limited as this is the binding liquid used to form agglomerates. Amount of water needed depends on soil texture (10%-30%). Heavy metal contents must be less than the criteria for non-leachable form. High water contents are addressed by predrying or by adding absorbent.

Efficiency Description: 92%-98% oil recovery

Government Funding:

Environmental Concerns: Possibility of fugitive emissions from solvent; recovered water MAY contain contaminant.

Health & Safety Plan Available: ☐

Regulatory Approvals None applied for as yet.

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 15

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $19.00

Assuming 10,000 tonnes. (Note: Setup time and Breakdown time both estimated at 2-3 days based on preliminary plant design). Operating cost will be dependent on moisture content of sediments as agglomeration process is water limited. Some tests have been successful at 20-30% moisture but this depends on particle size distribution and mineralogy of sediment. Over-saturated sediment would need to be partly dried or blended with dryer material. This requirement would increase operating cost.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean soil, recovered oil and some water

Developers:

National Research Council of Canada
Montreal Road Campus, Building M-12
Ottawa, Ontario
Canada K1A0R6
Notes

Contact: Sparks, Bryan D.
Phone: (613) 990-1769 Ext:
Fax: (613) 941-2529
Email: Bryan.Sparks@NRC.

Vendors:

Colt Engineering
#400-10201 Southport Rd.
Calgary, Alta.
Canada T2W4X9
Notes

Contact: Becker, Bob
Phone: (403) 258-8070 Ext:
Fax: (403) 252-2291
Email:

Terra Verda Inc.
#520, 560-6th Avenue
Calgary, Ontario
Canada T2P0S2
Notes

Contact: Crook, Phil
Phone: (403) 264-1102 Ext:
Fax: (403) 264-0842
Email:

Literature References:

Author:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

NRCC Solvent Extraction Soil Remediation (SESR)

20-Jan-98

Author: **Majid, A., Meadus, F.W., Sparks, B.D., et al**
Title: SESR - A Novel Canadian Technology for Remediating Petroleum and Heavy Metal Contaminated Soil
Journal: ACS Symposium: Extended Abstracts, Emerging Technologies for Hazardous Waste Management V, Vol. 1 pp 275-278 (1993) Date: **Jan 1993**

Author: **Sparks, B.D., Meadus, F.W., Majid, A., et al**
Title: A Novel Canadian Technology for Remediating Petroleum and Heavy Metal Contaminated Soil
Journal: Proceedings, ACS I&EC Special Symposium, Georgia, September 27-28th, 1993 Date: **Sep 1993**

Author: **Sparks, B.D., Meadus, Guo, I., et al**
Title: SESR-Solvent Extraction Soil Remediation-An Innovative Technology for the Remediation of Fine Textured Soils
Journal: Proceedings, Third Annual Symposium on Groundwater and Soil Remediation, Quebec City, September 8-10th, 1993 Date: **Sep 1993**

Author: **Sparks, B.D., Meadus, F.W., Toll, F.N., et al**
Title: An Integrated Technology for Remediating Petroleum Contaminated Soil
Journal: Proceedings, Sixth International Symposium on Agglomeration, Nagoya, Japan, November 15-17th, 1993 Date: **Nov 1993**

Author: **Sparks, B.D., Meadus, F.W.**
Title: Laboratory Evaluation of the SESR Process: Remediation of Fine Textured Soils Contaminated with Organic Materials
Journal: Proceedings, 87th Annual Meeting Air & Waste Management Association, Cincinnati, Ohio, June 19-24, 1994 Date: **Jun 1994**

Author: **Majid, A., Meadus, F.W., Sparks, B.D.**
Title: Concurrent Removal of Organic Contaminants and Immobilization of Heavy Metals in Soil or Sediments by Agglomeration
Journal: Proceedings, International Conference on Heavy Metals in the Environment; 2 pp 415-418, Sept. 1995 Date: **Sep 1995**

Author: **Sparks, B.D., Meadus, F.W., McNabb, D., et al**
Title: US Patent 5,453,133
Journal: Soil Remediation Process Date: **Sep 1995**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

NWRI Limnofix (In-Situ Chemical Injection)

20-Jan-98

TechID: 118

Technology Type: Biological, Chemical, Stabilization/Fixation

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, BTEX
Sulphides and Phosphorus

Media Treated: Sediment In-Situ, Soil In-Situ

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☒

Description:

The technology involves addition of oxidants and amendments, where required, to aquatic sediments in situ. Contaminants targeted by the treatment include BTEX, TPH, PAH's, odours (sulphides), and phosphorus. The required chemicals are delivered to the site and transferred to a boat. The chemicals are added to the sediments through a patented injection boom as the boat travels backwards. The added chemicals are denser than the sediment porewater and fall through the sediments so the ultimate treatment depth is greater than the 40 cm injection depth.

The added oxidant is used to convert the toxic sulphides to non-toxic sulphates; this allows the indigenous bacteria to biodegrade the contaminants. Some contaminants are precipitated from the porewater by the change in oxidation state of the sediments.

The technology has been tested and refined on many sediment types and contaminants in the laboratory and at 2 sites in the field (Hamilton Harbour, St. Marys River). In the laboratory contaminant removal is better (up to 99% removal of some contaminants) than in the field (20%-95% depending on the contaminant). Field implementation of the technology may require more than 1 application depending on site specific characteristics.

Limitations: The technology cannot be used where the sediments are clay or where lots of boulders/cobbles are present. PCB degradation has not been proven with this technology and metals have not specifically been treated. May not be suitable for navigational areas.

Efficiency Description: 60% efficient with one injection.

Government Funding: Great Lakes Cleanup Fund, ETP

Environmental Concerns: Care has to be taken to prevent sediment resuspension. Long-term monitoring is required and a series of treatments may be necessary.

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 2 Breakdown Time (days): 1

Feed Rate Average (Tonne/hr): 250

Cost: Capital Cost (US$): $18,500.00

Treatment Cost (US$/Tonne): $11.00 – $44.00 Average Cost (US$/Tonne): $18.00

Most equipment required can be leased locally. The process costs are based on treating 1 hectare/day of sediments to a depth of 40 cm. The above operating cost is based on a per treatment basis; depending on the site characteristics a series of treatments may be required.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Gases such as methane and other VOC's may be released from sediment during injection.

Developers:

National Water Research Institute
867 Lakeshore Road, P.O. Box 5050
Burlington, Ontario
Canada L7R 4A6
Notes

Contact: Murphy, Tom
Phone: (905) 336-4602 Ext:
Fax: (905) 336-8901
Email: Tom.Murphy@CCI

Vendors:

Golder Associates (HK) Ltd.
801 Stanhope House
Quarry Bay,
Hong Kong
Notes

Contact: Yuen, Clement
Phone: 85225623658 Ext:
Fax: 85225613890
Email: cyuen@hk.super.net

Golder Associates PTY Ltd.
72 Kelvin Grove Road
Normandy, Queensland
Australia 4059 -
Notes

Contact: McConnell, Allan
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Fax: 61738322596
Email:

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NWRI Limnofix (In-Situ Chemical Injection)

20-Jan-98

Golder Applied Technologies Inc.
3730 Chamblee Tucker Road
Atlanta, Georgia
USA 30341-
Notes

Contact: Baker, Ed
Phone: (770) 496-1893 Ext:
Fax: (770) 934-9476
Email:

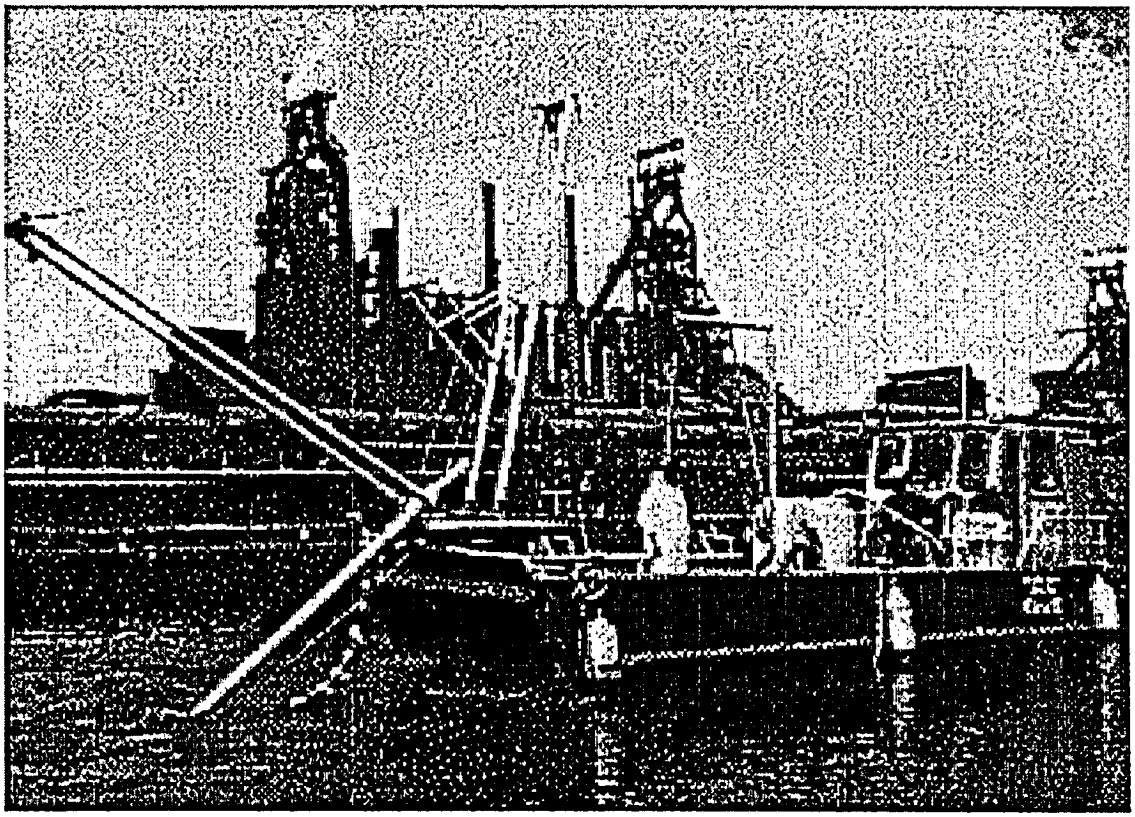
Limnofix/Golder Associates
2550 Argentia Road, Suite 213
Mississauga, Ontario
Canada L5N5R1
Notes

Contact: Babin, Jay
Phone: (905) 819-0600 Ext:
Fax: (905) 819-9922
Email: JBABIN@GOLDER.

Literature References:

Author: **Murphy, T.P., Brouwer, H., Babin, J.**
Title: In Situ Sediment Treatment of Dofasco Boatslip
Journal: 2nd International Conference on Dredging, Orlando, Florida, USA Date: **Jan 1994**

Author: **Murphy, T.; Moller, A.**
Title: In Situ Treatment of the Dofasco Boatslip Sediments
Journal: Proceedings of Sediment Remediation '95 Conference Date: **May 1995**



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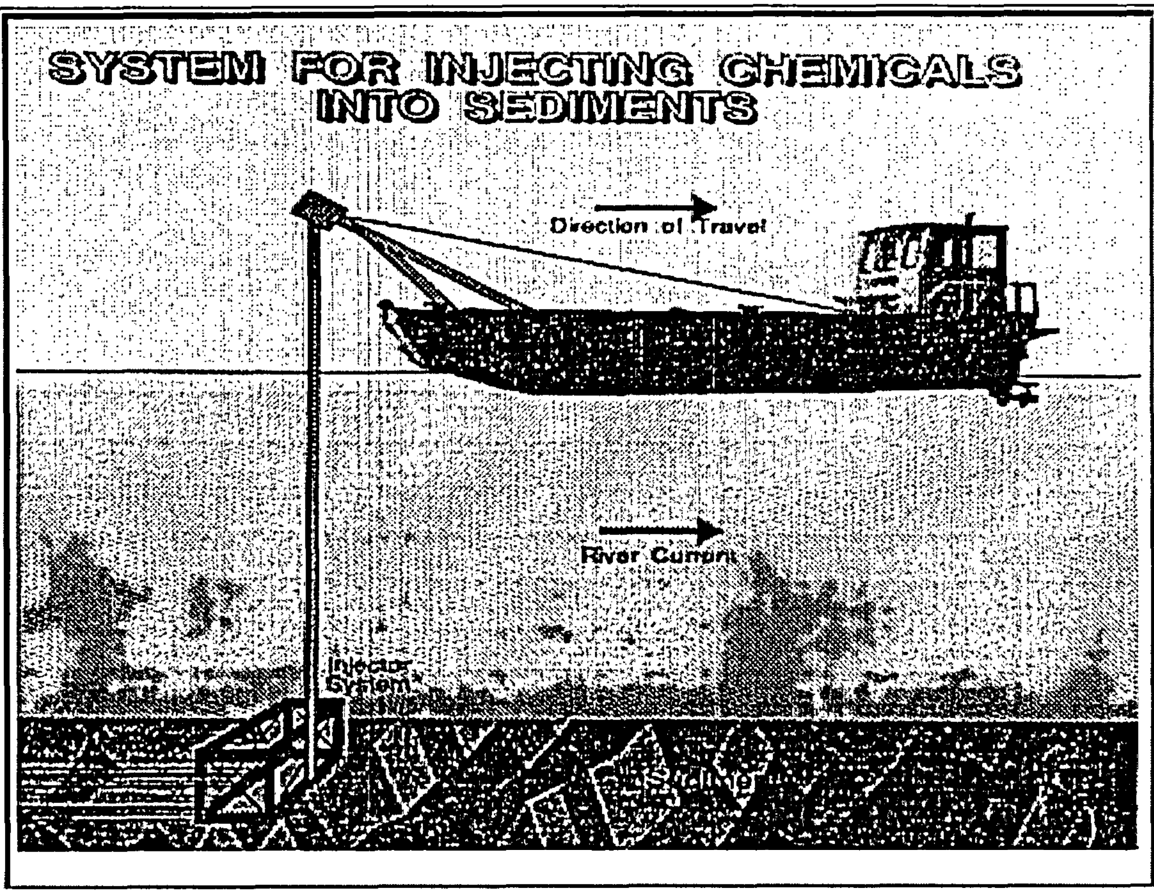

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NWRI Limnofix (In-Situ Chemical Injection)

20-Jan-98

Project: Venice — **Year: 93**

Location: Venice, Italy — Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated:			
Sulphides	Untreated: 1383 mg/kg	Treated: 97 mg/kg	93 % removal
Phosphorus	Untreated: 3.07 mg/l	Treated: 0.0031 mg/l	99 % removal
PAH's	Untreated: 159 mg/kg	Treated: 60 mg/kg	62 % removal
TPH's	Untreated: 1000 mg/kg	Treated: 490 mg/kg	51 % removal

Emissions/ByProducts:

Description: Treatment time for Sulphides : 17 days. Treatment time for all other contaminants : 39 days.

Project: Oil Company — **Year: 93**

Location: Buffalo, New York, USA — Bench Scale

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated:			
TPH's	Untreated: 350000 mg/kg	Treated: 140000 mg/kg	60 % removal
PAH's	Untreated: 5300 mg/kg	Treated: 2173 mg/kg	59 % removal
BTX's	Untreated: 1600 mg/kg	Treated: 528 mg/kg	67 % removal

Emissions/ByProducts:

Description: Treatment time for all three contaminants: 37 days.

Project: Spadina Boatslip — **Year: 93**

Location: Toronto, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated:			
TPH's	Untreated: 27500 mg/kg	Treated: 2750 mg/kg	90 % removal
PAH's	Untreated: 150 mg/kg	Treated: 27 mg/kg	82 % removal

Emissions/ByProducts:

Description: Treatment time for both contaminants: 44 days.

Project: Embayment A — **Year: 93**

Location: Toronto, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

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NWRI Limnofix (In-Situ Chemical Injection)

20-Jan-98

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated: TPH's Untreated: 1750 mg/kg Treated: 385 mg/kg 78 % removal
PAH's Untreated: 200 mg/kg Treated: 44 mg/kg 78 % removal

Emissions/ByProducts:

Description: Treatment time for both contaminants: 150 days.

Project: St. Marys River **Year: 93**

Location: Sault Ste. Marie, Ontario, Can Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated: Retene (a PAH) Untreated: 260 mg/kg Treated: 130 mg/kg 50 % removal
TPH's Untreated: 20000 mg/kg Treated: 2000 mg/kg 90 % removal
PAH's Untreated: 20 mg/kg Treated: 8 mg/kg 60 % removal

Note : Incubations without amendment.

Emissions/ByProducts:

Description: (Note: Treatment time for Retene and PAH's : 1 year. Treatment time for TPH's : 1.5 years).
Treatment of contaminated (TPH) sediments in the St. Marys River resulted in removal of sulphides and allowed the re-establishment of macrophytes in the shallow sediments (<50 cm). Treatment of the deeper sediments (up to 2 m) is continuing.

Project: Hamilton Harbour **Year: 93**

Location: Hamilton, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment

Contaminants Treated: TPH's Untreated: 20000 mg/kg Treated: 4400 mg/kg 78 % removal
PAH's Untreated: 1400 mg/kg Treated: 448 mg/kg 68 % removal

Emissions/ByProducts:

Description: (Note : Treatment time for both contaminants: 44 days). Pilot-scale treatments have been done in three sites ranging in water depths of 8 m to 22 m in Hamilton Harbour (Dofasco Boatslip, Randle Reef, and the deep basin). Various oxidants and amendments have been added to the contaminated (BTEX, TPH's and PAH's) sediments to precipitate the metals and stimulate biodegradation of the indigenous bacteria. Zinc and iron precipitated (80%-90%), BTEX, TPH, and PAH's decreased up to 80%, 50% and 25%, respectively, from one treatment; treatments are continuing.

Project: Hamilton Harbour **Year: 92**

Location: Hamilon Harbour Pilot Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$): $160,000.00

Setup Time (days): Breakdown Time (days):

Media Treated: The sediment in the highly contaminated areas is very oily and black. The oily material is generally referred to as "coal tar" although it is actually a mixture of coal tar, coal dust and other organic contaminants. The sediment is fine grained with a small proportion of debris (mainly iron ore nuggets).

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In laboratory bioassay tests the raw sediment kills all benthic and aquatic organisms within a few hours.

Contaminants Treated: Polycyclic aromatic hydrocarbons (PAHs) 800 - 2000 mg/kg
Total organic carbon 10 - 30 %
Metals:

Zinc	1000 - 3000 mg/kg
Lead	100 - 600 mg/kg
Iron	2 - 20 %

Emissions/ByProducts:

Description: The in-situ treatment demonstrated in this project was the Limnofix system. The technology was developed by the National Water Research Institute (a Canadian government agency) and was licensed to Golder Associates, a consulting company. The technology consists of a boat mounted injection boom, a row of injection "tines" attached to the end of the boom, a chemical mixing tank and pump and chemical additives. The object of the treatment is to inject oxidizing chemicals into the sediment. The theory is that once the sediment is oxidized microbiological activity will increase and organic contaminant concentrations will decrease.

For this demonstration a site of approximately 1 hectare in the most heavily contaminated area of the harbour was chosen for treatment. In August 1992 the sediment was injected with calcium nitrate, an oxidizing agent, in liquid form. The dosage was 1% by weight of the sediment solids. The injection equipment was designed to inject the calcium nitrate up to 20 cm. deep into the sediment. The injection occurred over a period of ? days.

Sampling of the sediment was carried out immediately before the injection and at 30 days, after treatment. Chemical analysis was carried out for nitrate, sulphides and PAHs. Bioassays (microtox) were also carried out. Long term monitoring of the sediment will also be carried out.

RESULTS
The results have been very encouraging. The injection system delivered all of the calcium nitrate into the top 6 cm. of sediment, however the sulphate levels are elevated in the top 15 cm. of sediment. This indicates that the oxidation effect of the injection is at least twice as deep as the actual injection depth. After two years the 15 PAHs measured had been reduced by approximately 50%.

Full Scale Cost Estimate:
For work in highly contaminated dredged material: $12-20/m2 ($48-80/m3)

REFERENCES

Murphy, T.P, H. Brouwer, M.E. Fox, E. Nagy, L. McArdle and A. Moller. 1990. Coal Tar Contamination Near Randle Reef, Hamilton Harbour. NWRI Contribution 90-17.*

Murphy, T., A. Moller, H. Brouwer, M. Fox and J. Babin. 1994. Review of In-Situ Treatment. Unpublished paper of the National Water Research Institute, Environment Canada, Burlington, Ontario (Publication pending).*

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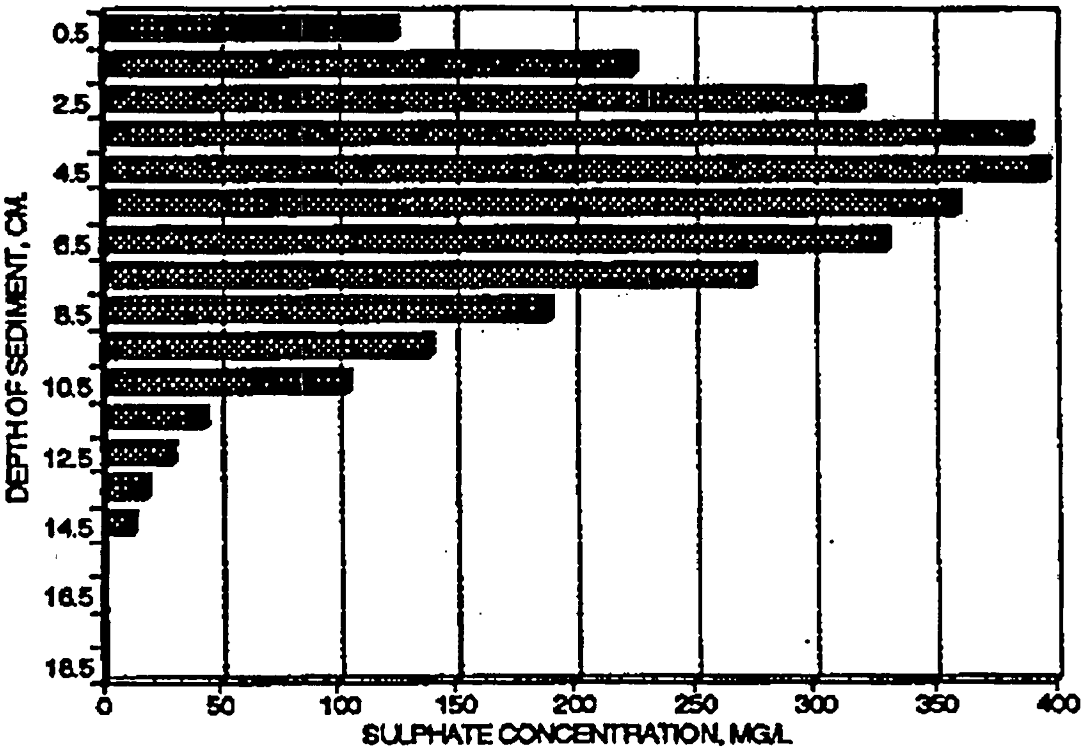
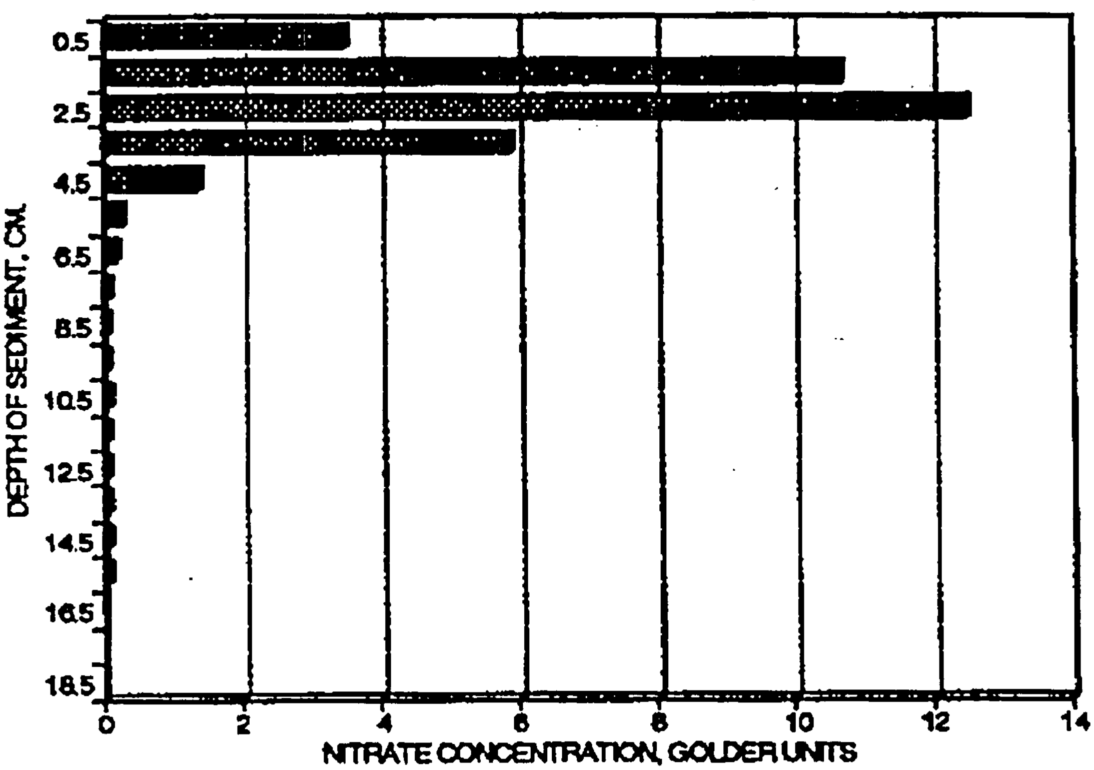
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.





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OHM Remediation Services Corp., Infrared Incineration System

20-Jan-98

Technology Type: Incineration

TechID: 141

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

This technology is the first TSCA-permitted (U.S.A.) mobile infrared system and first mobile unit permitted for PCB destruction in Canada. The primary electric-powered infrared furnace and secondary combustion chambers combine for a 99.9999% DRE of PCBs.

The incinerator system has also successfully treated dioxins, furans, pentachlorophenol, creosote, and other volatile and semi-volatile organics.

The feed required for efficient processing often requires additional preparation - screening, magnetic separation, shredding, dewatering, etc.

Limitations:

Efficiency Description: >99.9999% of PCBs

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Permitted by Toxic Substances Control Act; permit to operate in Canada. Six site specific regulatory approvals.

Setup/Feed: Setup Time (days): **14** Breakdown Time (days): **10**

Feed Rate Average (Tonne/hr): **6**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$100.00 – $500.00** Average Cost (US$/Tonne): **$300.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: <50 mg/m3 particulate, <75 mg/m3 HCl, <12 ng/m3 PCDD, ash, cleaned solids, and water requiring further treatment

Developers:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Vendors:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Literature References:

Author: US EPA
Title: Shirco Infrared Incineration System Application Analysis Report
Journal: EPA/540/A5-89/010 Date: **Jun 1989**

Author: McCartney, G.J.
Title: Remediation of PCB-Contaminated Soils by Mobile Infrared Thermal Destruction
Journal: Remediation Date: **Jan 1990**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

OHM Remediation Services Corp., Liquid Solids Separation

20-Jan-98

Technology Type: Biological, Chemical, Incineration, Organic Extraction, Physical, Soil Washing/Volume Reduction TechID: 143

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Halogenated Organics, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Sludges are separated in components: water, organics, solids. Liquid is treated to spec. and discharged. Organics are recovered and recycled.

Limitations: Sludges must be pumpable or dilutable to be pumpable. A minimum of 400 m^3 is needed to justify mob/demob expenses.

Efficiency Description: 50-90% volume reduction

Government Funding:

Environmental Concerns: Effluent must be sent to a permitted plant facility.

Health & Safety Plan Available: ☒

Regulatory Approvals Some air permits may be required if air emmission of VOC's are significant.

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 250

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): $100.00 – $500.00 Average Cost (US$/Tonne): $250.00

Unit costs for treatment of sediments contaminated with PCB's.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products:

Developers:

IFAD Inc.
1090 Cinclare Drive
Port Allen, LA
USA 70767-
Notes

Contact: Beardon, Chuck
Phone: (504) 389-9596 Ext:
Fax: (504) 387-4941
Email:

Vendors:

OHM Corporation
1090 Cinclare Drive
Port Allen, LA
USA 70767-
Notes

Contact: Beardon, Chuck
Phone: (504) 389-9596 Ext:
Fax: (504) 387-4941
Email:

Literature References:

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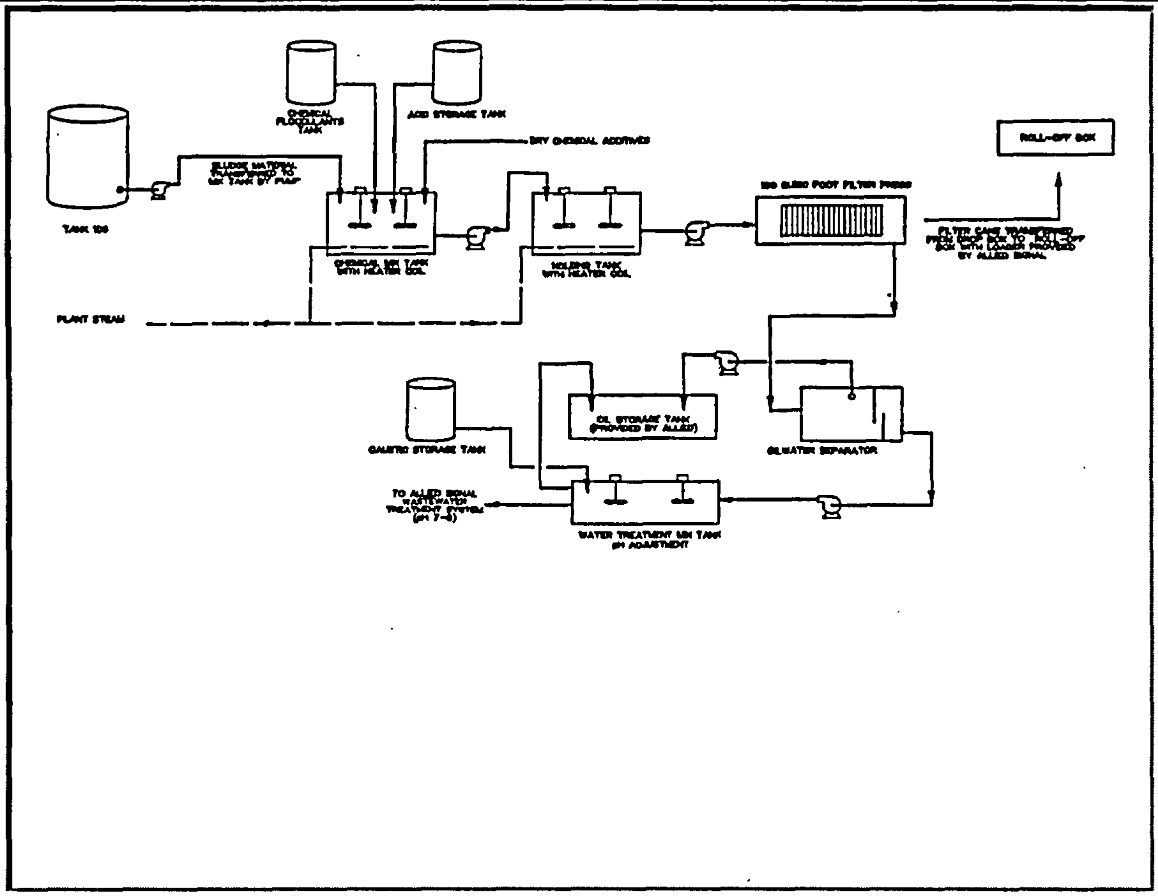
OHM Remediation Services Corp., Liquid Solids Separation

20-Jan-98



Project: PPG Industries

Location: Lake Chaples, LA, USA

Year: 93

Full Scale Demo

Client/Funding Agency	Contact	Phone
Private		

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 10000

Treatment Cost (US$): $5,000,000.00

Setup Time (days): 13

Breakdown Time (days): 13

Media Treated: Chlorinated organic/sediment.

Contaminants Treated:

	Untreated:	Treated:	% Removal
Chlorinated H.C.	>1,000 ug/g	<1,000 ug/g	50

Emissions/ByProducts: No emissions; no byproducts other than spent activated carbon.

Description:

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OHM Remediation Services Corp., PY*ROX 8200 Mobile Rotary Kiln Incinerator

20-Jan-98

TechID: 150

Technology Type: Thermal, Incineration

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Halogenated Organics, BTEX, Explosives, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The incineration system includes a rotary kiln incinerator, particularly well-suited for processing contaminate soils and sediments owing to its inherent ability for processing a wide variety of waste feed compositions and its ability to handle oversize feed material with minimal feed preparation. The rotary kiln operation allows feed of a wide range of soil types and consistencies.

The incineration system also includes a secondary combustion chamber (SCC) and an APC system also utilizing proven technologies to ensure destruction of organic compounds and compliance with regulatory agency emission requirements.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals US EPA Region III and Region VI Site Specific Approvals.

Setup/Feed: Setup Time (days): **90** Breakdown Time (days): **30**

Feed Rate Average (Tonne/hr): **18**

Cost: Capital Cost (US$): **$4,000,000.**

Treatment Cost (US$/Tonne): **$100.00 – $300.00** Average Cost (US$/Tonne): **$250.00**

25 % Moisture. Capital cost includes mobilization, setup, teardown, and demobilization.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: < 50 mg/m³ particulate; < 75 mg/m³ HCl; < 12 mg/m³ PCDD.

Developers:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Vendors:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Literature References:

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OHM Remediation Services Corp., Slurry-Phase Biological Treatment

20-Jan-98

TechID: 140

Technology Type: Biological, Soil Washing/Volume Reduction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX, Explosives

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Soil Screening and Slurry Preparation:

The slurry preparation/soil washing system is based on the premise that the contaminants tend to be concentrated in the humic and fine size fractions of the soil (i.e., organic matter, silt, and clay), and the contaminants associated with the coarse size fraction (i.e.sand and gravel) are primarily surficial. The objective is to reduce the volume of soil that requires further treatment in the slurry-phase bioreactors by concentrating the contaminants in a smaller volume of material while producing a washed soil fraction which meets the site treatment criteria.

The soil screening equipment is capable of processing 80 to 100 tonnes per hour of excavated material. The equipment is designed to reduce soil "clumps" prior to screening, remove material larger than 5 cm (concrete, rubble, timbers, etc.) and convey it into a debris stockpile. The material less than 5 cm is conveyed into a separate stockpile. The soil screening equipment is typically operated to screen all of the soil independent of the downstream processing schedule.

The slurry preparation/soil washing system processes the screened material at an average rate of 8 to 12 tonnes per hour. The process separates the stockpiled material into several size fractions utilizing both dry- and wet-screening operations. Material greater than 1 cm is screened and stockpiled and the material less than 1 cm is slurried to 40 to 60 % solids. The slurry is then screened to remove the washed size fraction, amended with slurry conditioning chemicals, nutrients, and pH adjustment, as required. The slurry is then pumped to the bioreactors.

Slurry Biotreatment:

The prepared slurry is transferred to one of four 800 m³ reactors (operating volume of 700 m³). The material is maintained in a well-mixed suspension to maximize mass transfer of the contaminants to the aqueous phase and provide maximum contact between the contaminated material and the microorganisms. At a slurry solids concentration of 25 % in the bioreactors, approximately 225 tonnes (dry weight basis) of material are treated in each reactor. The closed-top reactors are 12 m in diameter, 8 m in height and have a top-mounted agitator for suspension of the slurry. An air blower and distribution system provide the air (oxygen) to the bacteria in the slurry. An air blower and distribution system provide the air (oxygen) to the bacteria in the slurry. The reactor is monitored for temperature, dissolved oxygen uptake rate, pH, nutrients, and contaminant concentrations. At the completion of treatment, the slurry is pumped to the slurry dewatering system.

The slurry-phase bioreactors are typically operated in a batch mode; however, semi-continous or continous operation may be utilized based on the degradation kinetics of the contaminant(s). The residence time in the bioreactors is dependent on soil (sludge) matrix, contaminant type and concentration, degradation kinetics, and treatment criteria. Typical batch mode residence times in the slurry-phase reactors range from 5 to 50 days.

Slurry Dewatering:

The treated slurry is pumped to a filter press for dewatering of the slurry. The filter press has a capacity range of approximately 0.3 m³ to 0.4 m³ per minute for a 25 % solids slurry. The dewatered solids, typically 30 to 35 % moisture, are conveyed to a stockpile and the water is pumped to the water management tank. The water is stored for reuse in the slurry preparation system, minimizing the amount for off-site discharge.

The recycled water must be monitored for high salt concentrations, either from biological degradation end-products, or solubilized from the water matrix. Depending on the material and contaminant(s) treated, a small amount (approximately 10 %) of the recovered water should be discharged and make-up water used to minimize salt concentrations in the treatment system.

Limitations: Technology limited to contaminants amenable to biological degradation.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals NJDEPE Air Permit, MS Wastewater Discharge

Setup/Feed: Setup Time (days): 30 Breakdown Time (days): 30

Feed Rate Average (Tonne/hr): 12

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $200.00 – $230.00 Average Cost (US$/Tonne): $215.00

Database References: ATTIC ☐ VISITT ☒

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OHM Remediation Services Corp., Slurry-Phase Biological Treatment

20-Jan-98

Emissions / By-Products: Reactor off gas, treated solids, biomass

Developers:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: Jerger, Douglas
Phone: (419) 424-4932 Ext:
Fax: (419) 425-6031
Email: jerger@OHM.com

Vendors:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: Jerger, Douglas
Phone: (419) 424-4932 Ext:
Fax: (419) 425-6031
Email: jerger@OHM.com

Literature References:

Author: **Jerge, D., Woodhull, P.**
Title: Slurry-Phase Biological Treatment of Polycyclic Aromatic Hydrocarbons in Wood Preserving Wastes
Journal: Presented at the AWMA 87th Annual Meeting & Exhibation, Cincinnati, Ohio, 1994. Date: **Jan 1994**

Author: **Jerger, D., Erickson, S., Rigger, R.D.**
Title: Full-Scale Slurry Phase Biological Treatment of Wood Preserving Wastes
Journal: Presented at Superfund XV Conference and Exhibition, Washington, DC, 1994. Date: **Jan 1994**

Author: **Jerger, D., Woodhull, P., et al**
Title: An Evaluation of Slurry-Phase Bioremediation of MGP Soils
Journal: Presented at the Seventh International IGT Symposium on Gas, Oil, and Environmental Biotechnology, Colorado Springs, ... Date: **Jan 1994**

Author: **Woodhull, P., Jerger, D.**
Title: Slurry-Phase Biological Treatment for Remediation of Contaminated Material from Former MGP Sites
Journal: Presented at the I&EC Special Symposium American Chemical Society, Atlanta, GA, 1994 Date: **Jan 1994**

Author: **Woodhull, P., Jerger, D.**
Title: Bioremediation Using a Commercial Slurry-Phase Biological Treatment System
Journal: Remediation 4:3, pp. 353-362, 1994 Date: **Jan 1994**

Author: **Jerger, D., LaGoy, P.**
Title: Development of Soil Cleanup Standards for the Biological Treatment of Wood Preserving Wastes
Journal: Presented at Superfund XVI Conference and Exhibition, Washington, DC, 1995 Date: **Jan 1995**

Author: **Jerger, D., Woodhull, P.**
Title: Factors Influencing the Economics of a Commercial Slurry Phase Biological Treatment Process
Journal: Presented at Hazmat '95 Date: **Jan 1995**

Author: **Jerger, D., Woodhull, P.**
Title: Temperature Effects on The Slurry-Phase Biological Treatment of Polycyclic Aromatic Hydrocarbons
Journal: Presented at I&EC Special Symposium American Chemical Society, Atlanta, GA, USA, 1995 Date: **Jan 1995**

Author: **Woodhull, P., Jerger, D.**
Title: Temperature Effects on the Kinetics and Economics of Slurry-Phase Biological Treatment
Journal: Presented at In-Situ and On-Site Bioreclamation, The Third International Symposium, San Dego, California, 1995. Date: **Jan 1995**

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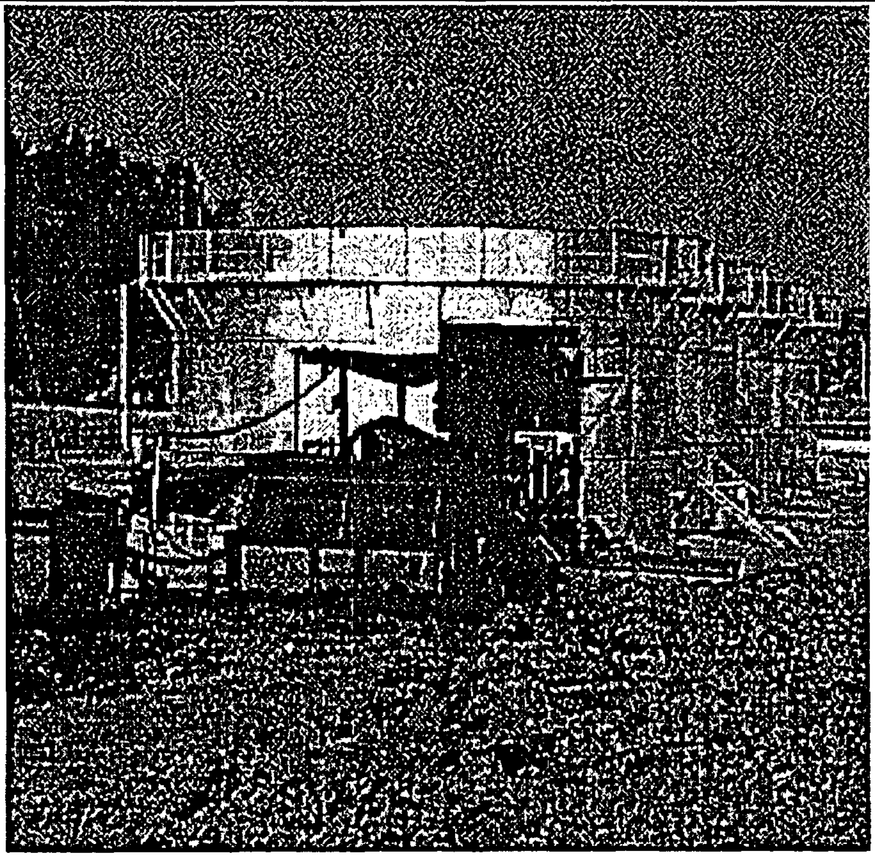

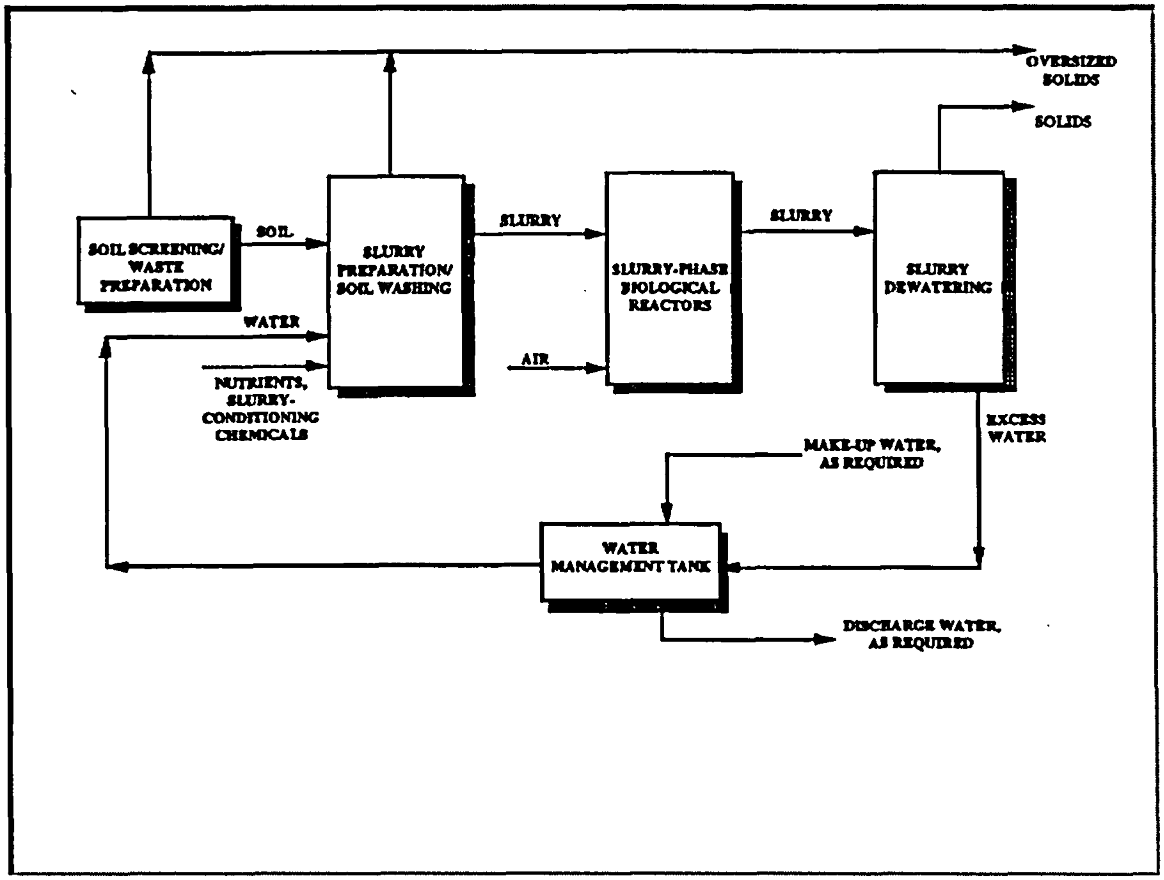

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OHM Remediation Services Corp., Slurry-Phase Biological Treatment

20-Jan-98

Project: IGT Field Demonstration **Year: 93**

Location: Elizabeth, New Jersey, USA Pilot Scale

Client/Funding Agency	Contact	Phone
Institute of Gas Technology	Vipul Srivastava	(708) 768-0539
Gas Research Inst.	Tom Hayes	(312) 399-8325

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 100

Treatment Cost (US$):

Setup Time (days): 30 Breakdown Time (days): 30

Media Treated: MGP-contaminated soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
PAH's	2000 mg/kg	100 mg/kg	95
CPAH's	200 mg/kg	25 mg/kg	70

Cleanup Goals: NJDEPE Soil Standards

Emissions/ByProducts: Reactor off gas, treated soil

Description: The pilot-scale treatment system consisted of a soil attrition scrubber, shaker screen, soil-slurry reactors, clarifier, drying bed, and support equipment systems for the addition of air, nutrients, hydrogen peroxide, Fenton's reagent, and inoculum. OHM performed detailed design of the slurry reactors including mixing, aeration, off-gas collection, and slurry sampling. Construction of the soil reactors was completed in OHM's corporate Fabrication facility. OHM also provided field operation and engineering support during the operation of the pilot-scale remediation system including assistance in obtaining an air permit form NJDEP for the project.

Project: Southeastern Wood Preserving Superfund Site **Year: 90**

Location: Canton, MS, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA Region IV	Don Rigger	(404) 347-3931
US EPA Region IV	Sharyn Erickson	(404) 347-3555

Not Audited

Feed Rate (Tonne/hr): 2 Amount Treated (Tonne): 14000

Treatment Cost (US$): $2,100,000.00

Setup Time (days): 45 Breakdown Time (days): 30

Media Treated: Sediments, Sludges, Soils

Contaminants Treated:

	Untreated:	Treated:	% Removal
Total PAH's	15,000 mg/kg	500 mg/kg	90
C-PAH's	2,500 mg/kg	100 mg/kg	60

Cleanup Goals: Total PAH's < 950 mg/kg; B(a) P Equivalents < 180 mg/kg

Emissions/ByProducts: Reactor off gas, treated soils

Description: OHM completed the full-scale, slurry-phase bioremediation of creosote-contaminated soil at the Southeastern Wood Preserving Site located in Canton, Mississippi. Approximately 7500 m^3 of contaminated soil was treated in four 750 m^3 slurry bioreactors. The soil was classified as RCRA K001 waste. The soil contained creosote and individual PAH constituents at levels exceeding 10,000 ppm. Extensive treatability studies were performed to optimize the kinetics of the bioremediation process. The results from these studies were used to develop the process design for 0.1 m^3 and 1.9 m^3 pilot-scale systems, and finally for the 750 m^3 units for the full-scale system.

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OHM Remediation Services Corp., X*TRAX (Thermal Desorption)

20-Jan-98

TechID: 219

Technology Type: Thermal, Organic Extraction, Physical

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The X*TRAX technology is a thermal desorption process designed to remove organic contaminants from soils, sludges, and other solid media. It is not an incinerator or a pyrolysis system. Chemical oxidation and reactions are not encouraged, and no combustion by-products are formed. The organic contaminants are removed as a condensed liquid, characterized by a high heat (BTU) rating, which may then be either destroyed in a permitted incinerator or used as a supplemental fuel.

Because of low operating temperatures (230 °C - 510 °C) and gas flow rates, this process is usually less expensive than incineration.

An externally-fired rotary dryer is used to volatilize the water and organic contaminants. The organic contaminants and water vapor driven from the solids are transported out of the dryer by an inert nitrogen carrier gas. The gas first passes through a high-energy scrubber. The gas then passes through two condensers in series, where it is cooled to less than 4 °C.

X*TRAX was originally developed by Chemical Waste Management Inc., but was purchased by OHM in 1995.

Limitations: Treatability tests should be performed on high boiling point contaminates in clay matrix.

Efficiency Description: Up to 99.9% removal can be achieved.

Government Funding: Great Lakes Cleanup Fund, ARCS, SITE

Environmental Concerns: Disposal of recovered products.

Health & Safety Plan Available: ☒

Regulatory Approvals US EPA Region I and US EPA Region IV (Site Specific).

Setup/Feed: Setup Time (days): 30 Breakdown Time (days): 14

Feed Rate Average (Tonne/hr): 7

Cost: Capital Cost (US$): $1,500,000.

Treatment Cost (US$/Tonne): $200.00 – $700.00 Average Cost (US$/Tonne): $400.00

Capital cost is mobilization, set-up and demobilization. Assumes 25% moisture.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: 300 ACFM exhaust.

Developers:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Vendors:

OHM Remediation Services Corp.
16406 U.S. Route 224 East
Findlay, OH
USA 45840-
Notes

Contact: McCartney, Greg
Phone: (419) 425-6003 Ext:
Fax: (419) 424-4991
Email:

Literature References:

Author: **Wastewater Technology Centre**
Title: X*TRAX Thermal Desorption Bench-Scale Demonstration
Journal: GLCF Fact Sheet Number 14 Date:

Author: **Daley, P.S.**
Title: Cleaning up Sites with On-Site Process Plants
Journal: Environmental Science & Technology Date: Aug 1989

Author: **Roy, K.**
Title: Thermal Separation Process Removes Organics from Soils and Sludges
Journal: Hazmat World Date: Mar 1992

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

OHM Remediation Services Corp., X*TRAX (Thermal Desorption) 20-Jan-98
~~Date: Mar 1992~~

Author: **Chemical Waste Management Inc.**
Title: Final Report and Appendices: X*TRAX Low Temperature Thermal Desorption Treatability Study on Thunder Bay Harbor
Journal: Sediment from Ontario, Canada, Vol. I - III
Prepared for COSTTEP
Date: **Apr 1993**

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OHM Remediation Services Corp., X*TRAX (Thermal Desorption)

20-Jan-98

Project: Thunder Bay Sediment **Year: 93**

Location: Geneva, Illinois, USA Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Thunder Bay Sediment

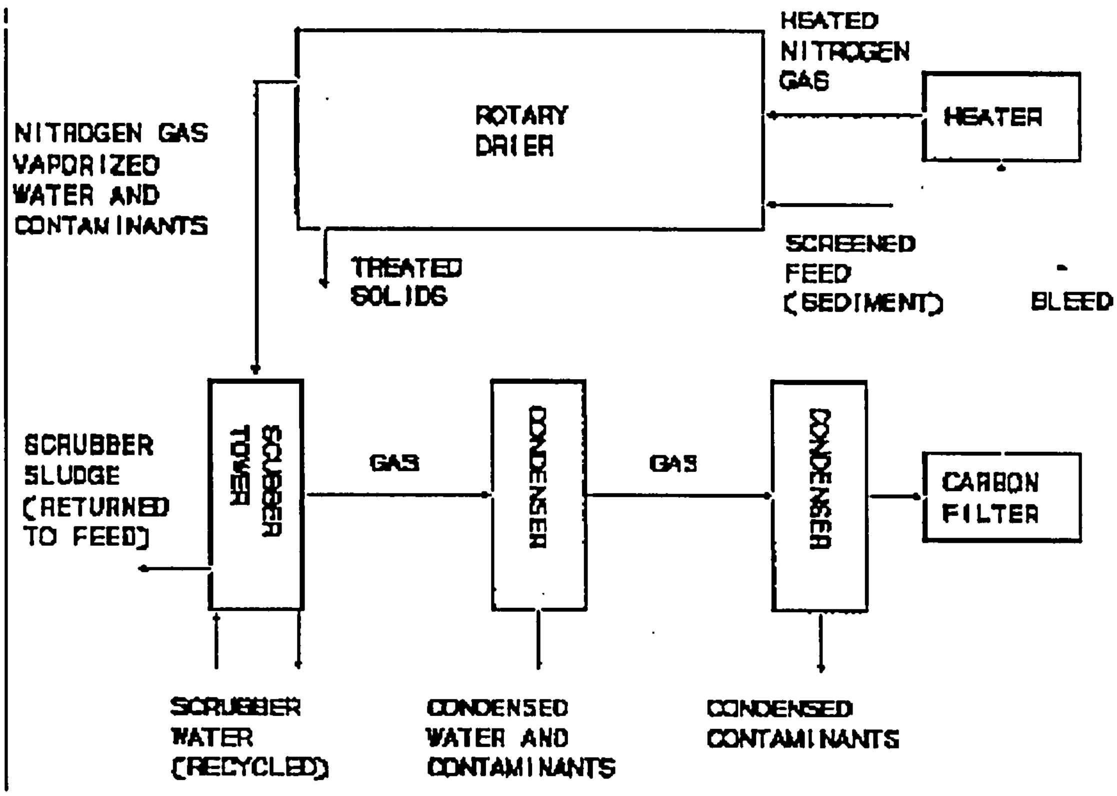
Contaminants Treated: Oil and Grease; TPH; PAH's

Compound	Feed (ppm)	Prod 2 (ppm)	% Removal
Oil & Grease (1)	70,000	4,300	93.0
Oil & Grease (2)	15,440	<210	98.6
Total PCBs	.615	0.62	89.9
Total PAHs (1)	13,172	33	99.7
Total PAHs (2)	8,456	9.6	99.9

Emissions/ByProducts:

Description: This project was undertaken by Chemical Waste Management. The technology used in this project is now owned by OHM Remediation Services Corporation.

Sediment from Thunder Bay Harbour was used in the study. The sediment was known to be heavily contaminated by organic wood preserving chemicals such as creosote. The contaminants of concern were considered to be polynuclear aromatic hydrocarbons (PAH's), chlorinated phenols and PCB's. The testing undertaken by CWM involved preliminary sample characterization following which X*TRAX treatability was assessed. Sediment was screened to 1/4" to remove oversize material with potential to damage the bench unit. The screened sediment was then fed through the drier to maintain a solids residence time of approximately 85 minutes.
Removal efficiencies for all organic componds exceeded 99.9%. However total constituent metals concentration remained relatively unchanged - as expected with thermal technology.



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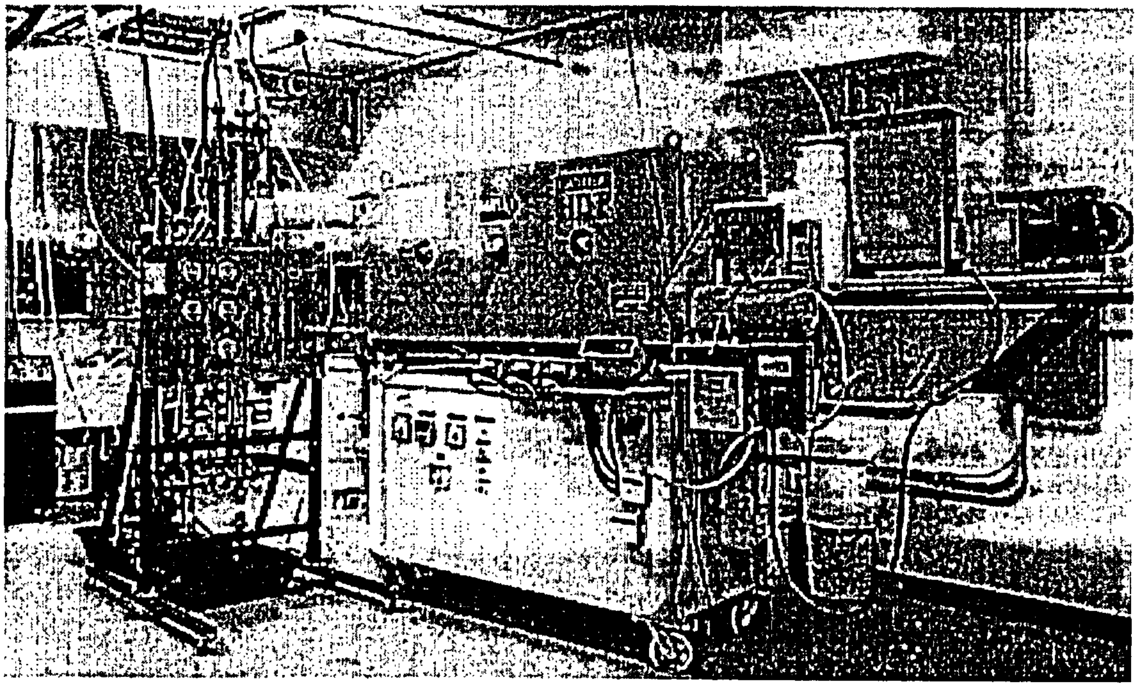
OHM Remediation Services Corp., X*TRAX (Thermal Desorption) 20-Jan-98



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Oleophilic Sieve (TM - Jan Kruyer)

20-Jan-98

TechID: 146

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: Petroleum Hydrocarbons, Heavy Metals

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Designed for the extraction of bitumen from oil sands the Oleophilic Sieve and proposed dredge have the potential to extract hydrocarbons and heavy metals from sediments. Based on the theory that hydrocarbons and metals have an affinity for oleophilic surfaces and sand, silt and clay do not, the sieve would retain the contaminants and allow clean sediment to pass. The sieve is then rinsed and the hydrocarbons and metals can be further treated or recovered for processing.

The Oleophilic Dredge would be an in-situ application of this process with the sediment being treated in the dredging process on a barge. As the cleaned sediment can be returned to the dredge site, the material requiring storage is reduced to the minimal volume of the extracted contaminants. Production rates for dredging would depend on the concentration of hydrocarbons and metals in the sediment.

It has been proposed that this process may also be used for the recovery of radioactive materials from non-radioactive bulk. In this method, the material to be treated is tumbled in a drum with oil and grease. The grease captures the radioactive material and the water prevents the transfer of non-radioactive material to the grease phase. Then the Oleophilic Sieve is used to separate the grease phase from the rest of the water-wet bulk. This method works for radioactive materials that are oil wetable.

Limitations:

Efficiency Description: Not Applicable

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.5

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean water and sediment, mineral and hydrocarbon products

Developers:

Oleophilic Sieve Development of Canada Ltd.
9707 - 67A Street
Edmonton, Alberta
Canada T6B 1S3
Notes

Contact: Kruyer, J.
Phone: (403) 466-9588 Ext:
Fax: (403) 466-9588
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Ortech Electrochemical Process

20-Jan-98

TechID: 147

Technology Type: Chemical

Contaminants Treated: Heavy Metals, VOCs, BTEX

Media Treated: Sediment Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

Ortech's present bench scale testing on the electrochemical treatment of contaminated liquids and porous media indicates that success could be met with the degradation of organics and the recovery of inorganics, specifically metals. Electrochemical oxidation has been shown to be effective in breaking organic contaminants down into water and carbon dioxide, and is a controllable process with respect to reactions and by-products. In addition electroosmosis can be utilized to facilitate the recovery/removal of metals.

Limitations:

Efficiency Description: Phenol 98% in 24-48 hrs; TCE 91% in 48 hrs

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.002

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Cost in 1986 for straight labour and analytical costs: $60,000 (Cdn.)

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water, recovered metals

Developers:

Ortech International
2395 Speakman Drive
Mississauga, Ontario
Canada L5K 1B3
Notes

Contact: Bellamy, K.
Phone: (905) 822-4111 Ext:
Fax: (905) 823-1446
Email:

Literature References:

Project: In-Situ Electrochemical Oxidation Reduction **Year: 86**

Location: Mississauga, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Internal Funding		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 1 Breakdown Time (days):

Media Treated:

Contaminants Treated: Phenol, Benzene, TCE, and other aromatics.
Copper concentration reduced from 40,000 ppm to 0.01 ppm over 2 hour period.

Emissions/ByProducts: Volatiles.

Description: Ran series of experiments (40-50) on process. Initial run with phenol. Progressed to trichloroethylene and perchloroethylene (Chlorinated Aliphatic Compounds)
Patent obtained based on flow-through reactor and in-situ model aquifer.

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Philip Environmental Services Corp., Bioremediation

20-Jan-98

TechID: 356

Technology Type: Biological

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Use of biopiles to achieve remediation by controlling air, moisture and nutrient levels, while controlling air emissions.

Limitations: Organic contaminants only.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): **10** Breakdown Time (days): **5**

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$15.00 – $30.00** Average Cost (US$/Tonne): **$22.50**

Sediment treatment ex-situ. Batch process.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Philip Environmental Services Corporation
345 Horner Ave.
Etobicoke, On
Canada M8W1Z6
Notes

Contact: Cathcart, Derek
Phone: (416) 253-6000 Ext:
Fax: (416) 253-6699
Email:

Literature References:

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Philip Environmental Services Corp., Eco-Safe

20-Jan-98

TechID: 354

Technology Type: Chemical, Physical

Contaminants Treated: Oil & Grease, Heavy Metals, Mercury

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

Physical, chemical fixation of solids and sludges. Two commercial operations for several years at Philip Facilities at 52 Imperial St. and 799 Parkdale in City of Hamilton.

Limitations: Some metals are easier than others to treat.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals MOEE CoFA 100140 and 100145

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$50.00 – $150.00** Average Cost (US$/Tonne): **$50.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Stabilized solid material.

Developers:

Philip Environmental Services Corporation
345 Horner Ave.
Etobicoke, On
Canada M8W1Z6
Notes

Contact: Cathcart, Derek
Phone: (416) 253-6000 Ext:
Fax: (416) 253-6699
Email:

Literature References:

Project: Hamilton Harbour Front Cleanup **Year: 92**

Location: Hamilton, Ontario, Canada Full Scale Demo

Client/Funding Agency	Contact	Phone
City of Hamilton	Chris Firth England	(905) 546-4337

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 20000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Contaminated soil

Contaminants Treated: Lead
Cadmium

Emissions/ByProducts:

Description: Full scale remediation of a toxic soil site.

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Philip Environmental Services Corp., Thermal Desorption

20-Jan-98

TechID: 355

Technology Type: Thermal, Physical

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Full scale operating thermal desorption facility. Operates as a fixed faciltiy at a site in North York, Ontario, Canada. Also can be moved to other sites to perform on-site site remediation work.

Limitations: Hydrocarbon contaminated solids only.

Efficiency Description:

Government Funding:

Environmental Concerns: Stack monitored, clean soil tested for compliance.

Health & Safety Plan Available: ☒

Regulatory Approvals Approvals in several provinces for facility, processing, and air.

Setup/Feed: Setup Time (days): 7 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 20

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $20.00 – $40.00 Average Cost (US$/Tonne): $30.00

Sediment is dewatered to < 20% moisture.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean soil, stack gases.

Developers:

Philip Environmental Services Corporation
345 Horner Ave.
Etobicoke, On
Canada M8W1Z6
Notes

Contact: Cathcart, Derek
Phone: (416) 253-6000 Ext:
Fax: (416) 253-6699
Email:

Literature References:

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Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

PSI Technoloigies, MelDAS (Metals Immobilization and Decontamination)

20-Jan-98

TechID: 128

Technology Type: Thermal

Contaminants Treated: Pesticides/Herbicides, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

This technology involves a modified incineration process in which high temperatures destroy organic contaminants in soil and concentrate metals into fly ash. The bulk of the soil ends up as bottom ash and is rendered nonleachable. The fly ash is then treated with a sorbent to immobilize the metals, as determined by the toxicity characteristic leaching procedure. The MelDAS process requires a sorbent fraction of less than 5 percent by soil weight.

Standard air pollution control devices clean the effluent gas stream. Hydrogen chloride and sulfur dioxide, which may be formed from the oxidation of chlorinated organics and sulfur compounds in the waste, are cleaned by alkaline scrubbers. Fly ash is captured by a particulate removal device, such as an electrostatic precipitator or baghouse. The only solid residues exiting the process are treated soils, which no longer contain organics and will not leach toxic metals.

The MelDAS process treats organics and heavy metals in soils, sediments and sludges. The process has been effective in treating arsenic, cadmium, chromium, lead, nickel, and zinc.

The MelDAS process is applicable to wastes contaminated with a combination of volatile metals and complex organic mixtures of low volatility. Possible MelDAS process applications include battery waste sites and urban sites containing lead paint or leaded gasoline, or a site contaminated with organometallics from disposal practices at chemical or pesticide manufacturing facilities.

Limitations:

Efficiency Description:

Government Funding: SITE

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$100.00**

Capital cost: $20.00/ton of soil. Operating cost includes disposal.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Stabilized solids, clean gases

Developers:

PSI Technologies
20 New England Business Center
Andover, MA
USA 01810-
Notes

Contact: Morency, Joe
Phone: (508) 689-0003 Ext:
Fax: (508) 689-3232
Email:

Vendors:

PSI Technologies
20 New England Business Center
Andover, MA
USA 01810-
Notes

Contact: Morency, Joe
Phone: (508) 689-0003 Ext:
Fax: (508) 689-3232
Email:

Literature References:

Author: **Morency, J.R., et al**
Title: Control of Trace Metal Species in Combustion Systems
Journal: Proceedings of AWMA Annual Meeting Date: **Jun 1994**

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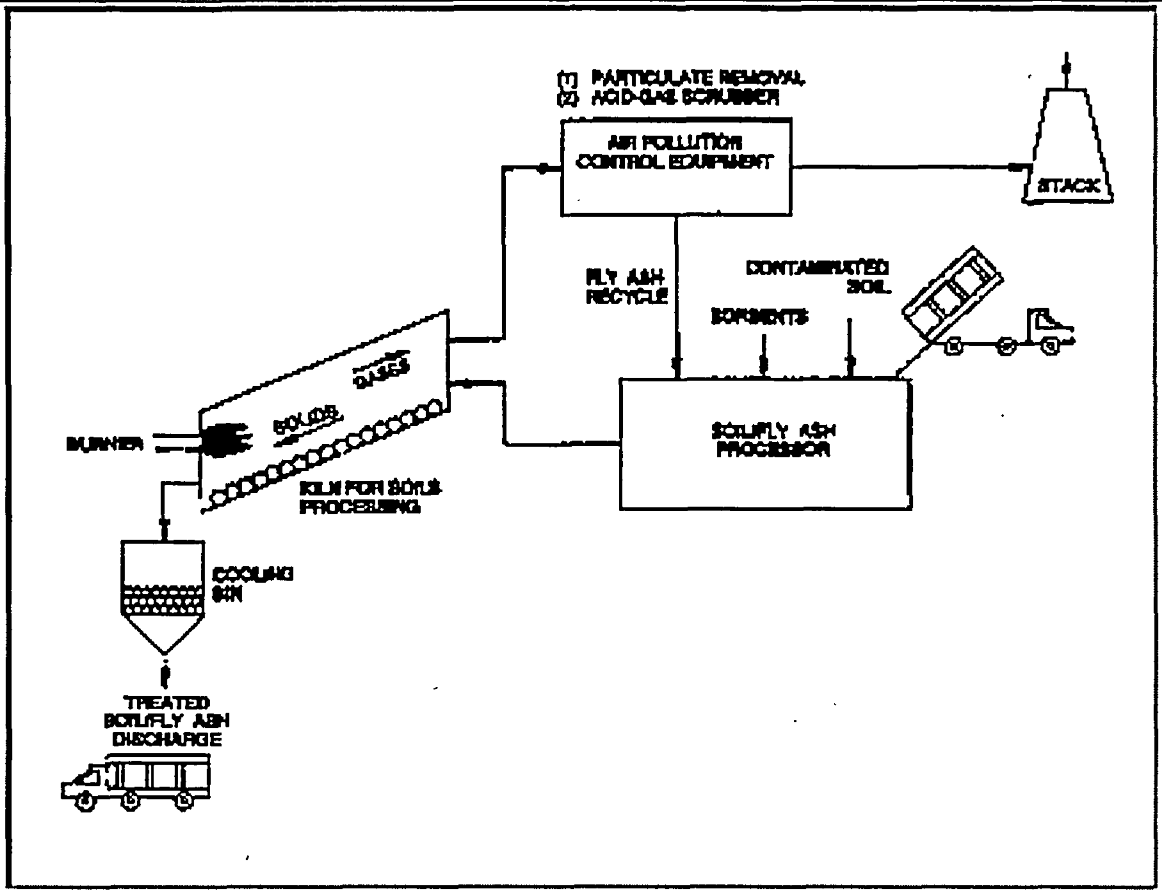
PSI Technoloigies, MelDAS (Metals Immobilization and Decontamination)

20-Jan-98



Project: Meidas **Year: 93**

Location: RTP, North Carolina, USA Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA	Mark Meckes	(513) 569-7348

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.14

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Soil and similar waste
0.13605

Contaminants Treated:

	Untreated:	Treated:	% Removal	Untr. Leach.	Tr. Leach
Lead					< 1
Arsenic					5

Leachate test method: TCLP
Cleanup Goals: Reduce leachability of toxic metals to below regulatory criteria.

Emissions/ByProducts:

Description: Incinerate soil in rotary kiln incinerator simulator at US EPA facility in RTP, N.C. Treat simulated wastes/sorbent briquettes in same unit.

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R. Cave Composting

20-Jan-98

TechID: 156

Technology Type: Biological

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

The sediment will be composted, with any required amendments, using an in-vessel composting system suitable for green field applications. The project will quantify the degradation of organic contamination and will establish the engineering process parameters required to expand the project to full scale (500 cu. m).

Limitations:

Efficiency Description: below detection level

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 5 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $40.00 – $55.00 Average Cost (US$/Tonne): $47.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: None

Developers:

R. Cave and Associates Ltd.
1155 North Service Rd., Unit 13
Oakville, Ontario
Canada L6M 3E3
Notes

Contact: Bennett, C.A.
Phone: (905) 825-8440 Ext:
Fax: (905) 825-8446
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Recycling Science International, Desorption and Vapor Extraction (DAVE) System

20-Jan-98

TechID: 61

Technology Type: Thermal, Organic Extraction, Post Treatment
Adsorption

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☒

Description:

RSI's low temperature, high volume Desorption and Vapor Extraction (DAVE) system separates toxic and hazardous waste from soil, sludge and sediments. The process is designed to separate and capture both volatile and semi-volatile organic contaminants from host materials. Nonvolatile inorganic contaminants (such as metals) in the waste feed do not inhibit the process, but are not removed. The clean processed soil (98 to 99 percent or more of incoming feed after rehydration) is returned to the excavation site or used for clean fill. The contaminants are captured and shipped off site for recycling or final disposal. This is accomplished in a closed process, with continuous, real time monitoring and numerous back-up systems.

Tested - Numerous EPA, state and local government supervised tests of the DAVE System have verified treatment capabilities with PCB, PAHs pesticides, VOCs semivolatile organics such as tetraethyl lead and mercury. This process can operate at 40 percent - 60 percent below incineration costs. Treated products from the DAVE system include: water suitable for discharge, oil that may be recycled as fuel, and solids that can be returned to the site as backfill. The processes can reduce the initial volume of contaminated material by more than 95 percent. The DAVE system can process 220 to 1,400 tonnes per day in a portable configuration. Capabilities of 4550 tonnes per day can be achieved in a fixed site, non portable mode.

Limitations: Materials which cannot be treated include tars, and substances which form tars at low temperatures and relatively short exposure times. Examples of the latter are some oxygenated petroleum products, polymer precursors, etc. Nonvolatile inorganic contaminants, such as metals, do not inhibit the process but are not removed. The DAVE System treatment process is most effective on matrices that are non-adsorptive and of low porosity.

Efficiency Description: Contaminants concentrated to 0.1% of original volume

Government Funding: SITE

Environmental Concerns: Stack emmisssions need to be monitored/clean solids need to be tested.

Health & Safety Plan Available: ☒

Regulatory Approvals U.S. Patent Nos. 4,402,274; 4,463,691; 4,685,220; 4,699,721; 4,778,606; 4,793,937; 5,273,629
Canada : 0001225665

Setup/Feed: Setup Time (days): **18** Breakdown Time (days): **18**

Feed Rate Average (Tonne/hr): **8.5**

Cost: Capital Cost (US$): **$1,500,000.**

Treatment Cost (US$/Tonne): **$61.00 – $89.00** Average Cost (US$/Tonne): **$75.00**

Assuming treatment of sediment ex-situ. Initial level: 10,000 ug/g; Final level: < 2.0 ug/g.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean dry solids (96-98% of feed), organic contaminants concentrated in a paste, spent carbon, treated wastewater, and collected dust.

Developers:

Recycling Sciences International Inc.
175 West Jackson Blvd
Chicago, IL
USA 60604-
Notes

Contact: Meenan, William
Phone: (312) 663-4242 Ext:
Fax: (312) 663-4269
Email:

Vendors:

Recycling Sciences International Inc.
175 West Jackson Blvd
Chicago, IL
USA 60604-
Notes

Contact: Meenan, William
Phone: (312) 663-4242 Ext:
Fax: (312) 663-4269
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Recycling Science International, Desorption and Vapor Extraction (DAVE) System *20-Jan-98*

Project: Gasoline Service Station **Year: 92**

Location: Marana, Arizona, USA Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 130

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Waukegan Harbor Site **Year: 84**

Location: Waukegan, Illinois, USA Full Scale Demo

Client/Funding Agency	Contact	Phone
TSCA Region 5	Sheldon Simon	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 20

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description:

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Resources Conservation Co., Basic Extraction Sludge Treatment (B.E.S.T.) *20-Jan-98*

Technology Type: Chemical, Organic Extraction, Post Treatment, Pre Treatment, Physical, Soil Washing/Volume Redu TechID: 23

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Tributyl-Tin, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

RCC's B.E.S.T. technology utilizes triethylamine to produce a solution that can be phase separated with heating and cooling, between 40 and 170 degrees Fahrenheit, to facilitate extraction. The process separates the feed into oil, water and solid fractions, recovers and recycles solvent, and concentrates the contaminants into a specific fraction for further treatment.

Contaminants successfully treated include PCBs, PAHs, VOCs, herbicides and pesticides.

Limitations: The B.E.S.T. process is not applicable for wastes containing only metals.

Efficiency Description: >99% PCBs; >98% PAHs; >99% Pesticides

Government Funding: Great Lakes Cleanup Fund, ARCS, SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Accepted into the SITE Demonstration Program in 1987; Permitted for TSCA Wastes (PCBs); Considered a waste minimization/recycle process by RCRA

Setup/Feed: Setup Time (days): **15** Breakdown Time (days): **7**

Feed Rate Average (Tonne/hr): **15**

Cost: Capital Cost (US$): **$5,000,000.**

Treatment Cost (US$/Tonne): **$99.00 – $106.00** Average Cost (US$/Tonne): **$103.00**

Based on asumptions stated in site applications analysis report.

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products: Contaminants concentrated in specific fraction - oil, water or solids; solvent is recycled

Developers:

Ionics RCC
3630 Cornus Ln.
Ellicott City, MD
USA 21042-
Notes

Contact: Weimer, Lanny
Phone: (301) 596-6066 Ext:
Fax: (410) 465-2887
Email: LDWEIMER@AOL.

Vendors:

Ionics RCC
3630 Cornus Ln.
Ellicott City, MD
USA 21042-
Notes

Contact: Weimer, Lanny
Phone: (301) 596-6066 Ext:
Fax: (410) 465-2887
Email: LDWEIMER@AOL.

Literature References:

Author: **Dial, C.J.**
Title: Bench-Scale Evaluation of RCC's Basic Extractive Sludge Treatment (B.E.S.T.) Process on Contaminated Sediments from the Buffalo, Saginaw, and Grand Calumet Rivers
Journal: EPA 905-R94-010
Date: **Oct 1994**

Author: **Resources Conservation Company**
Title: B.E.S.T. Bench-Scale Treatability Final Report: Thunder Bay Harbour Site: Lake Superior, Ontario
Journal: Prepared for Great Lakes Cleanup Fund
Date: **Nov 1994**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Resources Conservation Co., Basic Extraction Sludge Treatment (B.E.S.T.)

20-Jan-98

Project: Thunder Bay Harbour Site — **Year: 94**

Location: Bellevue, Washington, USA — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Wayne Randle, Wastewater Technology Centre — Phone: (905) 336-4665

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.002

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. Black coloured sediment with a pudding consistency.

Contaminants Treated:

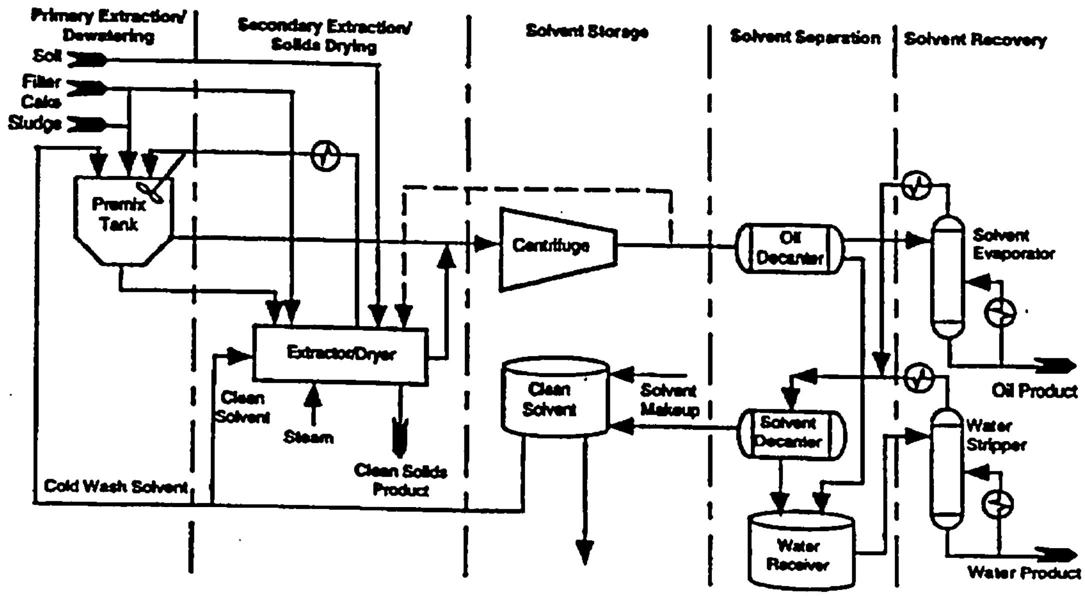
Total PAH's	Untreated	Treated	Removal (%)
after 6 extractions	1016 mg/kg	7.1 mg/kg	99.3
after 9 extractions	1016 mg/kg	7.3 mg/kg	99.3

Emissions/ByProducts: This process uses one vent to the atmosphere. RCC uses a refrigerated condenser and an auxiliary water scrubber system to reduce solvent emissions from the vent. A small amount of organic solvent remained in the sediment but biodegraded to zero in a few weeks.

Description: Treatability study on Thunder Bay sediment using the BEST solvent extraction method. See Map for process schematic. The B.E.S.T. process is a patented solvent extraction technology using triethlyamine as the solvent. A portion of sediment along with prechilled triethylamine was added to a resin kettle in a temperature controlled water bath at 1 degree C. Mixing was performed and the triethylamine solvent became coloured indicating extraction of organic compounds was occuring. The liquid extract in the micture was decanted off. A total of nine extractions were performed.

RESULTS
Nine rinsing cycles were used to obtain the results shown in the table above.

Cost Estimate:



Project: US EPA Site Demonstration Program — **Year: 92**

Location: Grand Calumet River — Pilot Scale

Client/Funding Agency	Contact	Phone
US EPA Site Program	M. Meckus	(513) 569-7348

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 5

Treatment Cost (US$):

Setup Time (days): 7 Breakdown Time (days): 7

Media Treated: Sediment

Contaminants Treated: PCB's Untreated: 425 ug/g Treated: 1.8 ug/g 99.6 % removal
PAH's Untreated: 70900 ug/g Treated: 510 ug/g 99.3 % removal

Emissions/ByProducts:

Description: Pilot Scale demonstration treating PCB and PAH contaminated sediments. Treatment cost: $170 US/tonne.

Project: Bayou Bonfouca **Year: 91**
Location: Slidell, Lousiana, USA Pilot Scale

Client/Funding Agency	Contact	Phone
CH2M Hill	D. Kashkashian	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Greenville Site **Year: 90**
Location: Greenville, Ohio, USA Pilot Scale

Client/Funding Agency	Contact	Phone
Textron	Paul Duff	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: API Wastes **Year: 89**
Location: , Lousiana, USA Pilot Scale

Client/Funding Agency	Contact	Phone
API	Frank Prince	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: General Refining **Year: 87**
Location: Garden City, Georgia, USA Full Scale Demo

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Resources Conservation Co., Basic Extraction Sludge Treatment (B.E.S.T.) *20-Jan-98*

Client/Funding Agency	Contact	Phone
US EPA Region 4	Shane Hitchcock	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 3400

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Alcoa Facility **Year:**

Location: Massena, NY, USA Pilot Scale

Client/Funding Agency	Contact	Phone
Alcoa	Tom Lightfoot	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Sediment

Contaminants Treated:

Emissions/ByProducts:

Description:

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Retech Plasma Centrifugal Furnace

20-Jan-98

Technology Type: Incineration

TechID: 162

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The plasma centrifugal furnace consists of two stacked reactors followed by a slag collection chamber and a gas treatment unit. The upper reactor is heated by the plasma arc torch which melts a slag in the reactor bowl, and provides the heat for organics to vapourise and burn, while non-volatile materials form part of the slag. In the secondary combustion chamber, temperatures are maintained at >1,200 °C and oxygen is added so that combustion of organics is completed.

The system operates in a semi-batch mode, made possible by the variable rotation of the primary combustion chamber. Under feed conditions, the rotation speed is "high" to prevent short circuiting of the waste. During pyrolysis and primary incineration, "moderate" speeds are used to enable the waste to mix well with the molten slag within the reactor bowl. Finally "low" rotational speed is applied to enable the slag to flow from the reactor. Note that some slag is always retained in the reactor bowl.

Pilot scale studies have indicated that the Plasma Centrifugal furnace is effective in treating the products of soil washing, chemicals, sludges, etc.

Limitations:

Efficiency Description: 99.99% to 99.9999% as needed

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Permitted in Switzerland.

Setup/Feed: Setup Time (days): 15 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $500.00 – $1,200.00 Average Cost (US$/Tonne): $850.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: <20 ppm total hydrocarbons deNOx is needed in Switzerland and Germany, and may be needed in other jurisdictions.

Developers:

Retech Inc.
P.O.Box 997, 100 Henry Station Rd.
Ukiah, CA
USA 95482-

Contact: Womack, R.K.
Phone: (707) 462-6522 Ext:
Fax: (707) 462-4103
Email:

Notes

Literature References:

Author: Retech Inc.
Title: Retech, Inc., Plasma Centrifugal Furnace : Applications Analysis Report
Journal: US EPA 540/A5-91/007 Date: Jun 1992

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

RTI ReTec Thermal Desorption

20-Jan-98

TechID: 159

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

A Holo-Flite Screw Processor, modified by ReTec, is the central component for this thermal desorption system. Auxillary units are for off-gas treatment and organics/water/solids separation.

The Screw Processor consists of twin intermeshing screws formed with screw augers contained within a jacketed vessel. The heat transfer medium, molten salt, is circulated through the augers and returns through the shaft. The medium is also circulated through the vessel jacket. Feed screened to 2 cm is fed to the Processor where it is heated to a temperature between 100 and 500 degrees Celsius, depending on the solids residence time. The intermeshing screws provide forward motion and efficient mixing of the contaminated material.

The resulting gas stream containing particulates, water vapours and organic vapours is drawn to the auxillary units. The gas is cooled, particulate is removed, and the organics and water are condensed before final discharge through an activated carbon bed. The organic condensate is recovered or recycled as hazardous waste fuel. The aqueous condensate is treated and recombined with solids for dust control.

The treated solids are cooled for handling.

Two passes are often applied - one at a low temperature followed by on at a higher temperature - so that the water and organics will be fully separated, and to save on heating costs.

Limitations:

Efficiency Description: 90%-99.99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Accepted in U.S. EPA SITE Program June 1991; Can be used under recycling exemption for RCRA

Setup/Feed: Setup Time (days): 20 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.5

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $300.00 – $500.00 Average Cost (US$/Tonne): $400.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean dry solids, organic condensate, aqueous condensate and clean gas

Developers:

Remediation Technologies Inc.
9 Pond Lake
Concord, MA
USA 01742-
Notes

Contact: McCabe, Mark
Phone: (508) 371-1422 Ext:
Fax: (508) 369-9279
Email:

Literature References:

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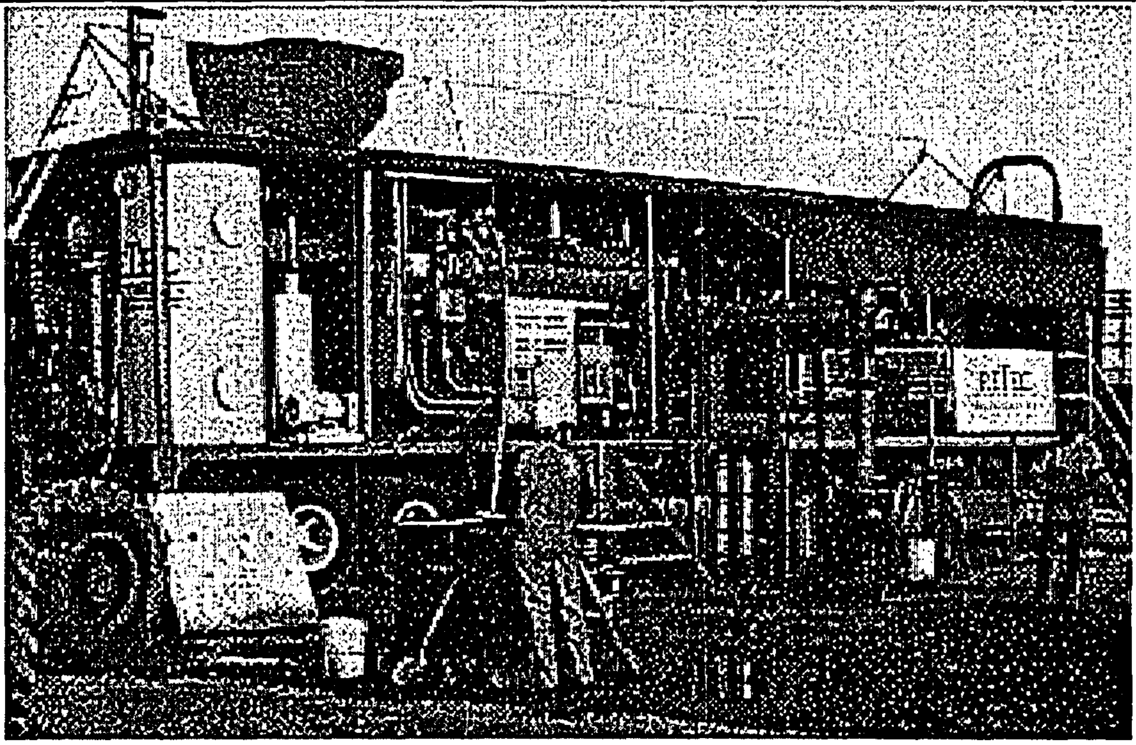

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Sanexen Biolysis Process

20-Jan-98

TechID: 330

Technology Type: Biological

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Canada **Portable:** ☒

Description:

The BIOLYSIS process is an aerobic bioremediation technology for sludges with high levels of hydrocarbons and high solids content. Treatment is within bioreactors, where hydrocarbons are degraded efficiently and no aqueous effluent is produced due to high water evaporation rates. Larger solid particles are treated with soil washing in a separate reactor and the overflow is treated. This technology is fully commercialized, and applied with a portable field scale unit (5 ton/day) or with a fixed unit (20 ton/day).

Limitations:

Efficiency Description: 75%-98%

Government Funding: DESRT

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Requires a Certificate of Approval on a case by case basis

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.3

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $80.00 – $200.00 Average Cost (US$/Tonne): $140.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water and biomass data is avaliable for trace organics in the air

Developers:

Sanexen Environmental Services, Inc.
185, The West Mall - Suite 1010
Etobicoke, Ontario
Canada M9C 5L5
Notes

Contact: Vocilka, Michael
Phone: (416) 622-5011 Ext:
Fax:
Email:

Vendors:

Sanexen Environmental Solutions, Inc.
579 Le Breton
Longueuil, Quebec
Canada J4G1R9
Notes

Contact: Paquin, Jean
Phone: (514) 646-7878 Ext:
Fax: (514) 646-5127
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Sanexen Biolysis Process

20-Jan-98

Project: Mansonville Site **Year: 93**

Location: Mansonville, Quebec, Canada Pilot Scale

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962
Quebec Ministry of the Environment		(418) 643-2073

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Mineral Oil and Grease

Emissions/ByProducts:

Description: Processing took place in-situ over a period of ten weeks using a hydraulic dredge together with aeration and mixing equipment to induce the required extracellular reactions and promote the desired endocellular degradation.

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Sanexen Sinre/DRAT

20-Jan-98

TechID: 186

Technology Type: Chemical

Contaminants Treated: PCB's, Pesticides/Herbicides

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Canada **Portable:** ☒

Description:

Sinre is the name of a process that biochemically degrades halogenated organics in sediments, sludges and soils.

Limitations:

Efficiency Description: Up to 99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): **10** Breakdown Time (days):

Feed Rate Average (Tonne/hr): **0.25**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$200.00 – $400.00** Average Cost (US$/Tonne): **$300.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Sanexen Environmental Services, Inc.
185, The West Mall - Suite 1010
Etobicoke, Ontario
Canada M9C 5L5
Notes

Contact: Vocilka, Michael
Phone: (416) 622-5011 Ext:
Fax:
Email:

Vendors:

Sanexen Environmental Solutions, Inc.
579 Le Breton
Longueuil, Quebec
Canada J4G1R9
Notes

Contact: Paquin, Jean
Phone: (514) 646-7878 Ext:
Fax: (514) 646-5127
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SBP, Slow Release Biocomposites for In-Situ Treatment of Sediments

20-Jan-98

Technology Type: Biological — TechID: 349

Contaminants Treated: PAH's, PCB's, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX

Media Treated: Sediment In-Situ, Soil In-Situ, Sludge

Development Stage: Pilot Scale — **Country Of Origin:** USA — **Portable:** ☒

Description:

Microencapsulation technology can enhance in-situ treatment of contaminated sediments and ex-situ treatment of contaminated soils (slurry reactors) by stimulating native microorganisms with slow release oxygen and nutrients. Specially selected microorganisms can also be encapsulated. In-situ, encapsulation serves as a delivery mechanism to introduce organisms and nutrients into the contaminated sediment. Several biocomposite matrices are known but our work has focused on polyvinyl alcohol (PVA) because it is a suitable carrier for the solid oxygen and it will gradually dissolve in water acting as a slow-release agent. PVA biocomposites are prepared according to our modification of the procedure described by C. Baker (EC patent No. 88870182.8).

Limitations: Cannot treat metals in sediments/sludges.

Efficiency Description: 90%

Government Funding:

Environmental Concerns: Requires long-term monitoring.

Health & Safety Plan Available: ☒

Regulatory Approvals Department of Defense approved.

Setup/Feed: Setup Time (days): 7 — Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 1

Cost: Capital Cost (US$): $200,000.00

Treatment Cost (US$/Tonne): $10.00 – $15.00 — Average Cost (US$/Tonne): $12.00

Treatment depth not to exceed 0.6 m. NOTE: Feed rate usually not calculated for this type of technology since it is a batch process. It is an approximation based on a single application area.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

SBP Technologies, Inc.
c/o U.S. EPA, Sabine Island
Gulf Breeze, FL
USA 32561-
Notes

Contact: Mueller, J.
Phone: (904) 934-9352 Ext:
Fax: (904) 934-2420
Email: 75357.1357@compu

Vendors:

SBP Technologies, Inc.
c/o U.S. EPA, Sabine Island
Gulf Breeze, FL
USA 32561-
Notes

Contact: Mueller, J.
Phone: (904) 934-9352 Ext:
Fax: (904) 934-2420
Email: 75357.1357@compu

Literature References:

Author: **Lin, J-E, Wang, H.Y., Hickey, B.F.**
Title: Use of Coimmobilized Biological Systems to Degrade Toxic Organic Compounds
Journal: Biotech Bioengineer (38:273-9) — Date: **Jan 1991**

Author: **Lin, J-E, Mueller, J.G., Pritchard, P.H.**
Title: Use of Encapsulated Microorganisms as Inoculants for Bioremediation
Journal: American Chemical Society Special Session on Bioremediation of Soils & Sediments, Sept. 21-23, Atlanta, GA, USA — Date: **Sep 1992**

Author: **Mueller, J.G., Lin, J-E, Lantz, S.E., Pritchard, P.H.**
Title: Recent Developments in Cleanup Technologies
Journal: Remediation (Summer) — Date: **Jan 1993**

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SBP, Slow Release Biocomposites for In-Situ Treatment of Sediments

20-Jan-98

Project: Confidential Client
Location: Gulf Breeze, FL, USA

Year:
Bench Scale

Client/Funding Agency	Contact	Phone
Confidential		

Not Audited

Feed Rate (Tonne/hr):
Amount Treated (Tonne): 0.005
Treatment Cost (US$): $15,000.00
Setup Time (days): 5
Breakdown Time (days): 5
Media Treated: Sediment

Contaminants Treated:

	Untreated:	Treated:
PAH's	1270 mg/kg	730 mg/kg

Cleanup Goals: 130 mg/kg total PAH's.

Emissions/ByProducts:

Description: An 8 week laboratory study was conducted to examine PAH biodegradation by polyvinyl alcohol (PVA) encapsulated cells. Creosote contaminated sediment was seeded with PVA encapsulated sphingomonas paucimobilis strain EPA 505 and an encapsulted solid oxygen source. Respiration & PAH removal were measured.

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Shirco Infrared Thermal Destruction

20-Jan-98

TechID: 172

Technology Type: Incineration

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** Italy **Portable:** ☒

Description:

The infrared thermal destruction technology generates its heat from electrically-powered silicon carbide rods. Waste is exposed to this heat in a primary chamber where air is used to control the oxidation rate. Residual ash is quenched and conveyed to a hopper for analysis of contaminants, with the liquid effluent being directed to a clarifier and activated carbon filter for reuse. Off-gases are treated in a second chamber at higher temperatures with greater residence time. A venturi scrubber is employed for particulate removal and a packed tower scrubber neutralizes acid vapor.

Designed to except solid/sludge feed, liquid wastes can be mixed with sand or soil for treatment. Optimal waste characteristics for processing are as listed:

- Particle size, 5 microns to 5 cm
- Moisture content, <50% by weight
- Density, 30 to 130 lbs/cubic ft
- Heating value, <10,000 Btu/lb
- Chlorine content, <5% by weight
- Sulfur content, <5% by weight
- Phosphorus, 0 to 300 ppm
- pH, 5 to 9
- Alkali metals, <1% by weight

Limitations:

Efficiency Description: >99.99% for air emissions

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$800.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: The process is capable of meeting both Resource Conservation and Recovery Act (RCRA) and Toxic Substances Control Act (TSCA) destruction removal efficiency (DRE) requirements for air and particulate emissions.

Developers:

Shirco Infrared Systems, Inc.

,

Contact:
Phone: Ext:
Fax:
Email:

Notes

Vendors:

Gruppo Italimpresse
Via Sambuca Pistoiese 57
Rome,
Italy 00148-

Contact:
Phone: 39-6-8802001 Ext:
Fax: (396) 886-8123
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Silt N.V. Bacteriological Remediation

20-Jan-98

TechID: 176

Technology Type: Biological

Contaminants Treated: PAH's, Oil & Grease, Tributyl-Tin

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☐

Description:

This biological technology can be applied in-situ or ex-situ. For both processes the bacteria are injected, along with a stabilizing agent, and thoroughly mixed. The ex-situ process requires the construction of a confined disposal site for the treatment of dredged sediment. The cleansed sediment is suitable for unconfined disposal.

Bench scale tests are required to establish operational parameters before full scale implementation can commence.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): **30** Breakdown Time (days): **30**

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$25.00 – $40.00** Average Cost (US$/Tonne): **$32.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Carbon dioxide, water, biomass and sediment

Developers:

Silt N.V.
Haven 1025
Zwyndrecht,
Belgium B-2070

Contact: van Craenenbroeck, K.
Phone: (323) 250-5411 Ext:
Fax: (323) 250-5253
Email:

Notes

Literature References:

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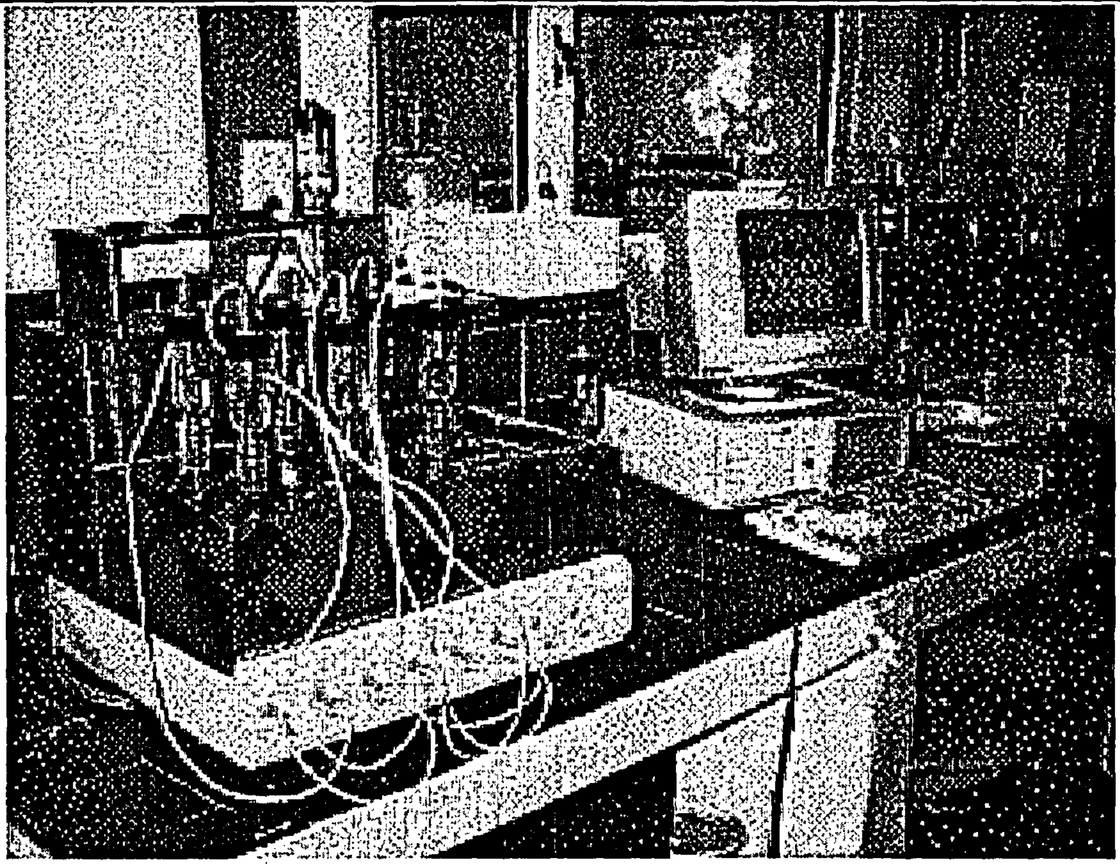

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Silt N.V. Extraction

20-Jan-98

TechID: 177

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** Belgium **Portable:** ☐

Description:

The technology under development is described as chemical extraction and washing. Silt N.V. proposes to utilize a cleansing process for sand, under licence, and a patented process for sandy mud. The clean fraction separated through these processes is intended for unconfined disposal and re-use in road construction, shore protection and landscaping. The toxic fraction requires confined diposal.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 1

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $60.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Silt N.V.
Haven 1025
Zwyndrecht,
Belgium B-2070
Notes

Contact: van Craenenbroeck, K.
Phone: (323) 250-5411 Ext:
Fax: (323) 250-5253
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Silt N.V. Fixation

20-Jan-98

TechID: 178

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

The technology is designed to immobilize heavy metals and stabilize sludges through the addition of a complexant. The process can be applied in-situ through injection, or on dredged sediment during its transportation. Bench scale tests are first required to optimize the existing process.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $25.00 – $40.00 Average Cost (US$/Tonne): $32.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Sediment containing fixed contaminants

Developers:

Silt N.V.
Haven 1025
Zwyndrecht,
Belgium B-2070
Notes

Contact: van Craenenbroeck, K.
Phone: (323) 250-5411 Ext:
Fax: (323) 250-5253
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Silt N.V. Fraction Separation and Dewatering

20-Jan-98

Technology Type: Pre Treatment

TechID: 179

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☒

Description:

Silt N.V.. possess two types of plants for fraction separation and dewatering: The Krankeloon, and the HSS 2000. The Krankeloon is a mobile pilot plant equipped with a hydrocyclone for separation, a belt-press for dewatering, and a water treatment basin. The HSS 2000 is a full scale floating plant consisting of 36 hydrocyclones, 6 belt presses and water purification facilities. Both processes can be implemented at a full scale immediately.

Silt N.V. also possess various technologies to follow this volume reduction process, see SILT Bacteriological Remediation; SILT Fixation; SILT Extraction.

Limitations:

Efficiency Description: 84%-97% sand in bottom flow and 91%-99% sludge in top flow of hydrocyclones

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 125

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $25.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean fraction (sand, silt, water) and contaminated fraction (silt, clay)

Developers:

Silt N.V.
Haven 1025-Scheldedijk 30
Zwijndrecht,
Belgium B-2070

Contact: De Brabandere, Jef
Phone: (323) 250-5411 Ext:
Fax: (323) 250-5253
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

Sipac Soliroc

20-Jan-98

TechID: 191

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** Belgium **Portable:** ☐

Description:

Soliroc is a low-cost and effective treatment of hazardous wastes containing heavy metals. The process offers excellent cost and environmental safety benefits to the owner and processor of industrial waste. Soliroc is a cold stabilization process which permanently transforms sludges, liquids, filtercakes and ashes into an environmentally safe impermeable monolithic structure or aggregate. The process neutralizes harmful elements by using silicate reagent and additives to create inert metal silicates incorporated in concrete resembliing matrix.

The highly stable end-product can be used safely for landfill or construction purposes. Thanks to the sound chemical bonding of the material there is no risk of reversion. The Soliroc process relies on readily obtainable reagents. The costs are much lower than for encapsulation or vitrifying and the end-product can be dumped at considerable lower costs than the original waste.

The Soliroc process has been a leading stabilization technology since its introduction in 1975. A broad knowledge of treating all kinds of wastes has been obtained from research, development and operational experience. Sipac S.A., a sister company of ESDEX, is patent holder and runs the Soliroc process research center.

Various plants are in operation. In Northern Italy, the Modena plant, has produced over 1.2 million tonnes of Soliroc material. The actual annual capacity of the plant is 100,000 tonnes. In Belgium, Indaver N.V. in Antwerp, another plant treats mainly mineral sludges from the nonferrous metal industry. Annual plant capacity is 15,000 tonnes. In Monthey, Switzerland, a plant with an annual capacity of 6,000 tonnes is treating fly ash and residues from municipal solidwaste (MSW) incineration. In Soin, Switzerland, a plant has been built for the treatment of fly ash; annual capacty 1,000 tonnes. In Huelva, Spain, a plant operates for the treatment of liquids and sludges containing heavy metals with an annual capacity of 25,000 tonnes.

Limitations:

Efficiency Description: 90-99% fixation rate

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 120 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $50.00

Capital cost: $60.00 /tonne.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: No emissions

Developers:

Sipac S.A.
Rue des Freres Taymans 32
Tubize,
Belgium B-1480
Notes

Contact:
Phone: 32 2 3557700 Ext:
Fax: 32 2 3555109
Email:

Vendors:

Esdex BV
Beneluxlaan, 9
3527 HS Utrecht,
The Netherlands
Notes

Contact:
Phone: 31 30 957955 Ext:
Fax: 31 30 940022
Email:

Literature References:

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Silt N.V. ITORICS System

20-Jan-98

TechID: 222

Technology Type: Biological, Metal Extraction

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** Belgium **Portable:** ☒

Description:

The ITORICS System was developed by Silt N.V. of Belgium to be a total treatment technique for soils and sediments. The system incorporates as many phases of treatment as are necessary to completely remediate the feed material. In general ITORICS has a pre-treatment step to remove debris, a metals removal step and a biological treatment step.

The metals removal phase of the process involves the washing of the feed with chemical agents which break the adsorptive bonds of the metals and the solid particles. The chemicals used are selected on a case basis based on bench scale testing. Desorption occurs in a specially designed reactor. Metals are then precipitated out of solution and recovered.

The biological treatment phase also occurs in specially designed slurry reactors. Conditions inside the reactor are selected based on bench scale testing. In some cases innocula, nutrients and chemical additives are used. The reactors are aerobic and are monitored constantly for a number of process parameters.

Limitations: Cannot achieve more than 90% metals removal and 95% PAH removal.

Efficiency Description: Bench scale tests with sediment from Thunder Bay harbour achieved the following results: 80% zinc removal; 69 % lead removal; 86% nickel removal; 94% PAH destruction (108 days)

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): **30** Breakdown Time (days): **30**

Feed Rate Average (Tonne/hr): **22**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$30.00 – $100.00** Average Cost (US$/Tonne): **$65.00**

Rate Average: 100 - 250 tonne/day

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Silt N.V.
Haven 1025-Scheldedijk 30
Zwijndrecht,
Belgium B-2070
Notes

Contact: De Brabandere, Jef
Phone: (323) 250-5411 Ext:
Fax: (323) 250-5253
Email:

Literature References:

Author: **Brabandere J., Proot, K.**
Title: Bench Scale Demonstration of the ITORICS Process on Thunder Bay Harbour Sediment
Journal: Prepared for the Great Lakes Cleanup Fund Date: **May 1995**

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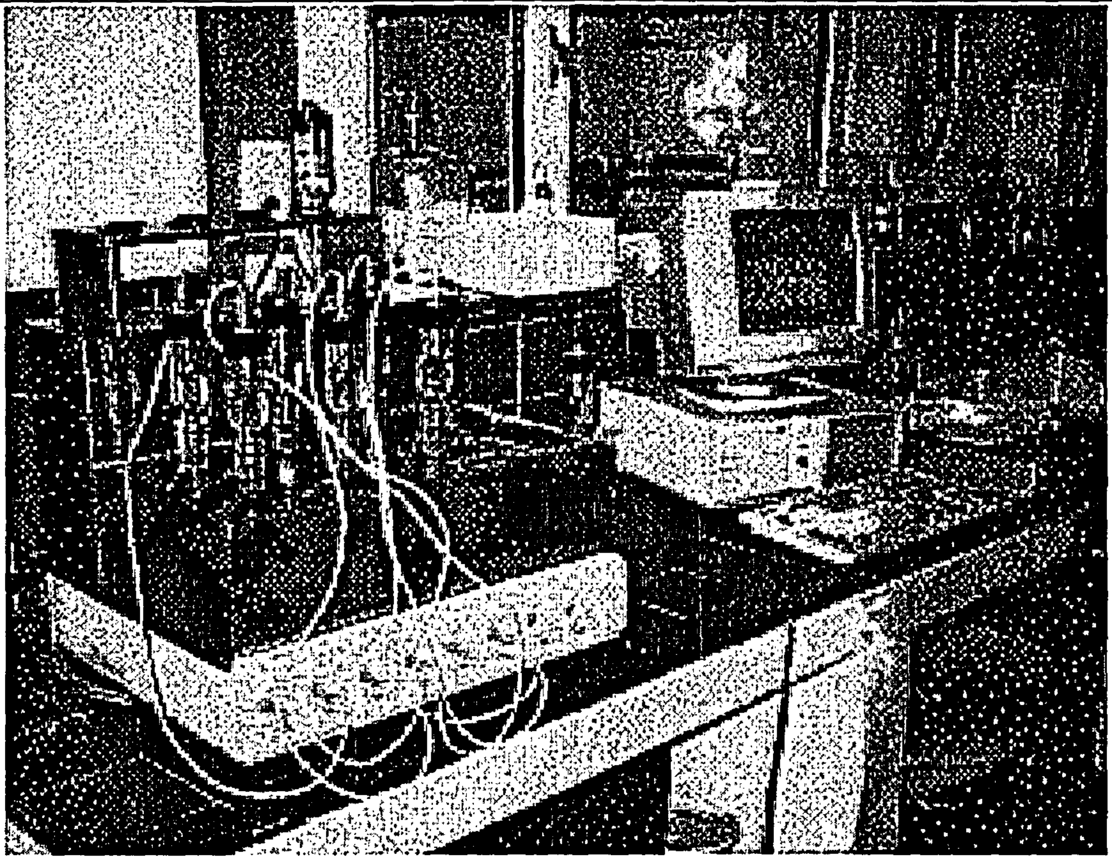
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Silt N.V. ITORICS System



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Silt N.V. ITORICS System

20-Jan-98

Project: Thunder Bay Harbour Sediment

Location: Thunder Bay, Ontario, Canada

Year: 94

Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. Mostly silt and clay.

Granulometry	Percent > 63µ	Percent < 63µ
Total sediment	6.59	93.41

Dry matter content was found to be 44.6% by weight.
Mean density (w/v) 1.2890 (g/ml)

Contaminants Treated: PAHs. Heavy metals (see Bar Graph).

Emissions/ByProducts:

Description: Treatability Study for PAHs using proprietary blends to maximize bioremediation. Five different procedures were tested: Blank, X-blend, X-blend with additive, Y-blend, Y-blend with additive. The blends were bacterial, the additives were chemical. The tests were performed in reactors which were monitored for temperature, pH, oxygen consumption rate and PAH destruction. Total test period was 108 days.

Metals removal using washing agents was undertaken. An optimization program was followed by an optimized test run.

RESULTS
An 80-95% reduction in PAHs was achieved after 3 months.

	Untreated (µg/g)	Treated (µg/g)
Total PAH	1867	384

For metals removal data see bar graph.

Cost Estimate:
Unit cost for large scale operation is estimated tat US$218/tonne dry sediment.

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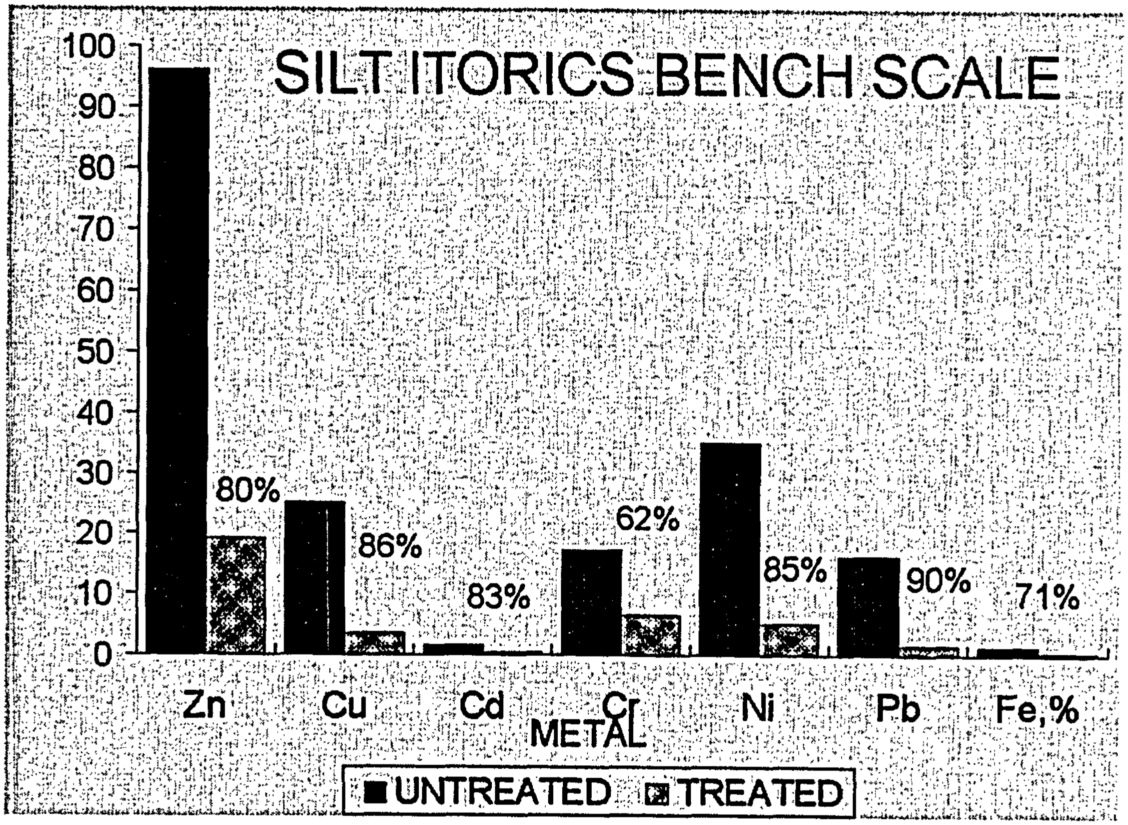

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Solidiwaste Technology L.P., Urrichem Process

20-Jan-98

TechID: 270

Technology Type: Thermal, Biological, Chemical, Stabilization/Fixation, Post Treatment, Pre Treatment, Physical, Soil Washing/Volume Reduction

Capping

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, Halogenated Organics, BTEX, Dioxins/Furans

Arsenic

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

We have two basic methods of operation. Choice depends upon project restraints and costs. No matter what method we select we always develop a mix design that is geared towards the contaminants of concern, future use of site, site limitations and project owners' expectations.

We can either use our in situ pulvermixer or static semi batch operation. In some instances we have produced one cubic yard/meter blocks. This allows for easy removal, should that be called for at a future time.

Our process can be adapted to eliminate any odor and kill fecal coliform. We also have a unique filtration system, together with new dredge technology developed by one of our associates especially for silt materials getting low moisture solids ready for processing. We prefer to design for an end use for the treated waste be it soil or beach erosion or use as fishing reefs.

Limitations: We prefer not to treat high organic wastes with this system.

Efficiency Description:

Government Funding: SITE, Superfund

Environmental Concerns: Monitor off gases and provide dust control in certain applications and in pretreatment chemicals.

Health & Safety Plan Available: ☒

Regulatory Approvals State of Texas & Massachusetts US EPA SITE program.
European Community & Taiwan. Mexico (SEDESOL)

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 4

Feed Rate Average (Tonne/hr): 125

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $28.00 – $38.00 Average Cost (US$/Tonne): $33.00

Sediments will contain no more than 25% moisture and bulk powders will cost no more than $75 per ton, average $35 per ton. Average treatment cost : $28.00-$38.00 ton, assuming contaminant to be various metals and organics; initial level 20,000 ug/g dry and final level <50 ug/g dry.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Solidiwaste Technology
830 Lee St.
Manhattan, KS
USA 66502-
Notes

Contact: Fan, L.T.
Phone: (913) 539-2656 Ext:
Fax: (913) 539-2656
Email:

Solidiwaste Technology L.P.
309 Buckingham Drive
Port Neches, TX
USA 77651-
Notes

Contact: Somerville, R.B.
Phone: (409) 727-5696 Ext:
Fax: (409) 727-5696
Email:

Vendors:

Fine-Tie Environmental Eng. Co.
113 Ta-Hsin Rd., Ta-She Hsiang
Kaohsiung,
Taiwan R.O.C.
Notes

Contact: Chou, S.T.
Phone: (07) 226-3653 Ext:
Fax:
Email:

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Solidiwaste Technology L.P., Urrichem Process

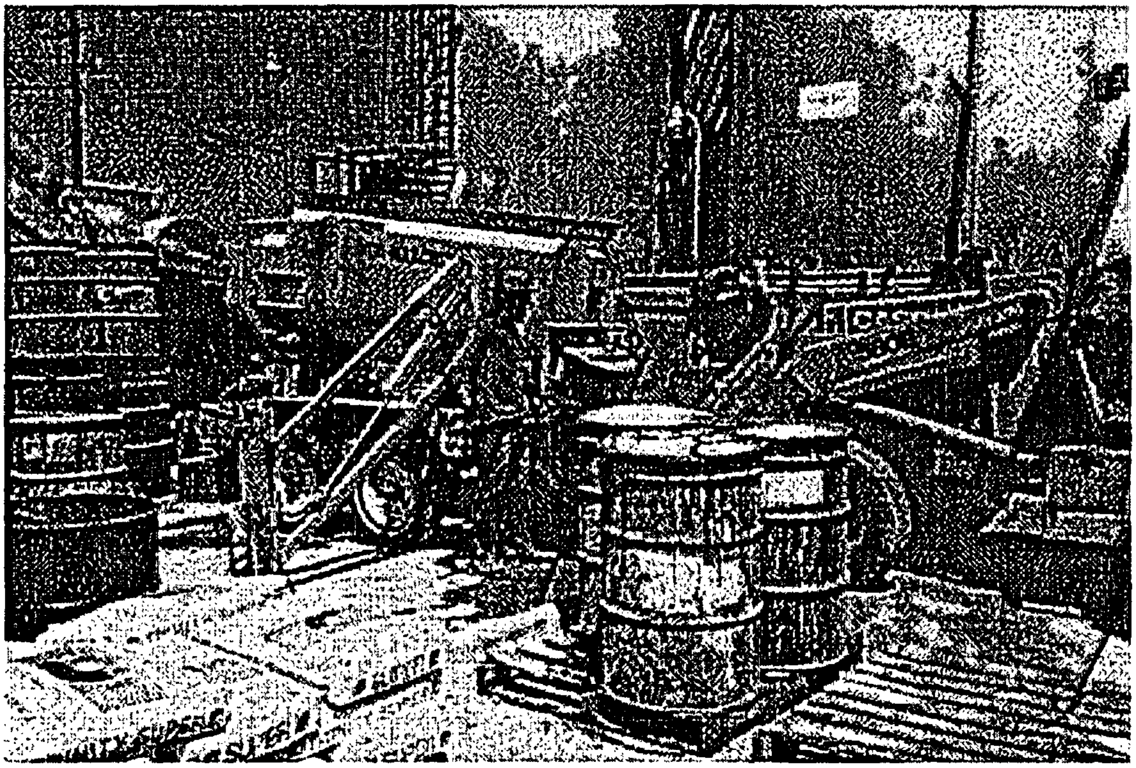
20-Jan-98

Trident Environmental Inc.
1181 South Rogers Circle, Bay 12
Boca Raton, FL
USA 33487-

Contact: Donaldson, Tom
Phone: (407) 995-7444 Ext:
Fax: (407) 995-6858
Email:

Notes

Literature References:



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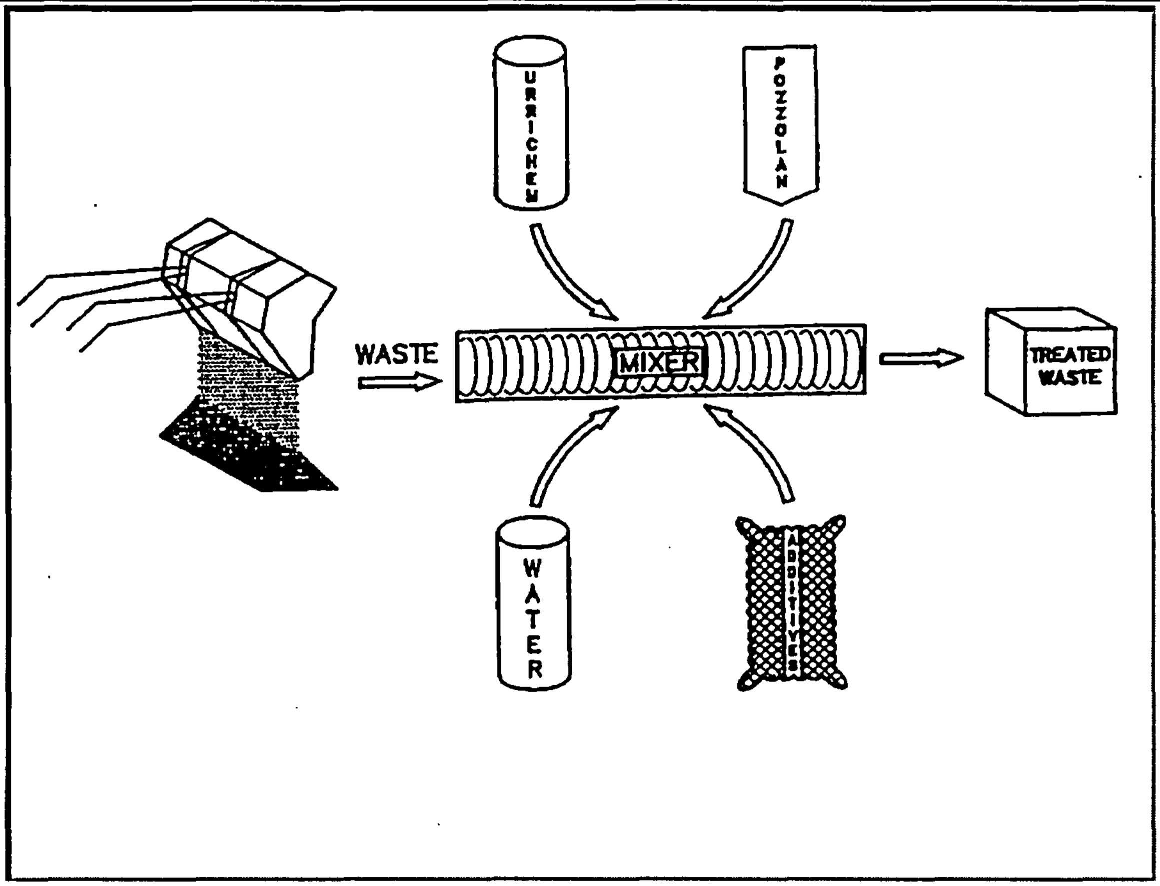
Solidiwaste Technology L.P., Urrichem Process

20-Jan-98



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Solidiwaste Technology L.P., Urrichem Process

20-Jan-98

Project: Old Henley Oil Co. **Year: 89**

Location: Norphlet, Arkansas Commercial

Client/Funding Agency	Contact	Phone
US EPA / State of Arkansas	John Martin	(214) 655-2275

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: Oil & grease; pH; Chrome; Lead

Emissions/ByProducts:

Description: Stabilize work area with lime & rock. Set up bulk powder silos and tanks. Anchor in place run water & power. Set up work perimeter/safety train. Install blending equipment. Dry test run.

Project: Imperial Oil Co./ Champion Chemical Co. **Year: 88**

Location: Morganville, NJ Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA SITE Program	Dr. Walter Grube	(513) 569-7798

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: pH; Oil & grease; lead; arsenic; zinc

Emissions/ByProducts:

Description: Build one cubic yard forms for solidified waste. Set up work area Health & Safety decontamination area. Storage silo water and other equipment. Blending equipment left on trailer. All waste water was solidified at culmination of test.

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Sonofloc Process

20-Jan-98

TechID: 193

Technology Type: Post Treatment, Pre Treatment

Contaminants Treated:

Media Treated: Sediment Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Austria **Portable:** ☒

Description:

The proposed technology utilizes ultra sonic waves to cause suspended particles to coagulate and settle, facilitating their removal. No chemicals are used in this process which is compatible with classical separation methods. Developed in Austria, a joint venture has been established with Triton to scale up the technology for wastewater treatment in Canada.

Limitations: Useful only for removing suspended solids from the water (process water, decant water)

Efficiency Description: Not Applicable

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Not Applicable

Developers:

SONOFLOC Separationstechnologien GmbH
AM Kanal 27
Vienna,
Austria A-1110
Notes

Contact: Hager, F.
Phone: 43-1-74040262 Ext:
Fax: 43-1-74040740
Email:

Vendors:

Sonofloc Environmental Technologies Ltd.
#120-13511 Commerce Parkway
Richmond, B.C.
Canada V6V 2L1
Notes

Contact: Poppleton, J.A.
Phone: (604) 279-2039 Ext:
Fax: (604) 279-2047
Email:

Literature References:

Author: **Triton Environmental Consultants Ltd.**
Title: Examination of the Feasibility of Using Acoustic Separation for the Treatment of Contaminated Sediments
Journal: Prepared for Great Lakes Cleanup Fund Date: **Jul 1992**

Author: **Wastewater Technology Centre**
Title: Sonofloc Feasibility Study - Welland River Sediment
Journal: Great Lakes Cleanup Fund Fact Sheet Number 8 Date: **Apr 1994**

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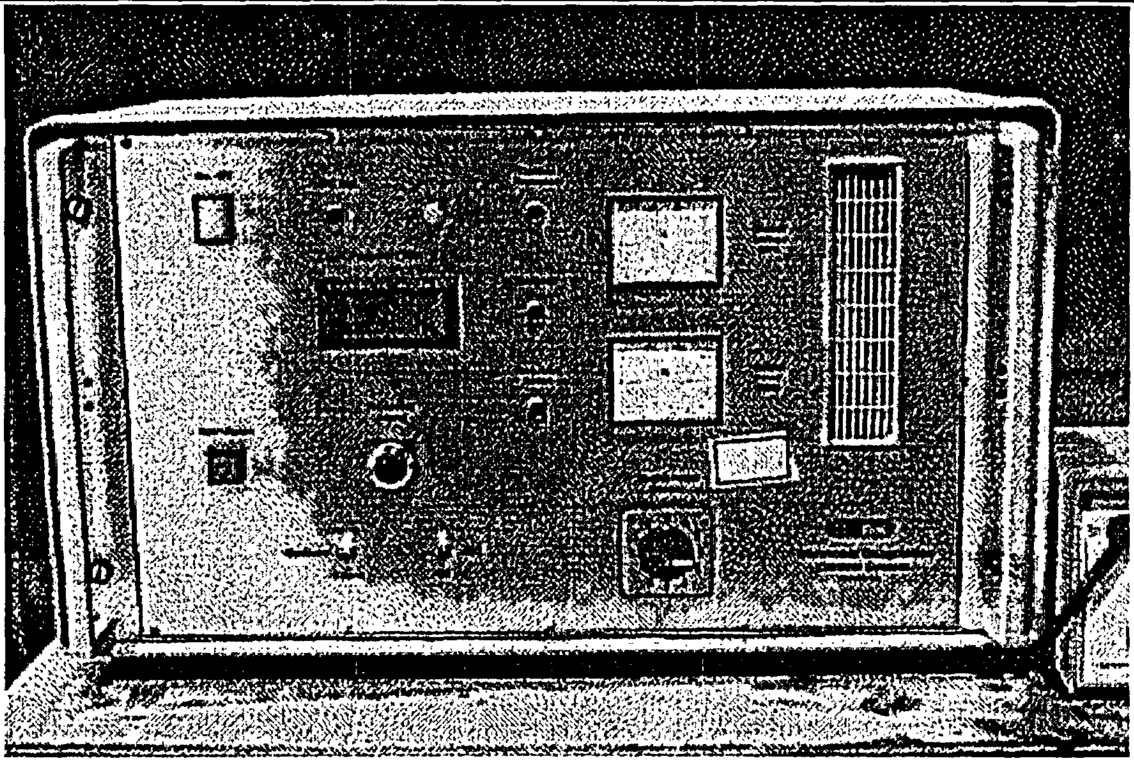
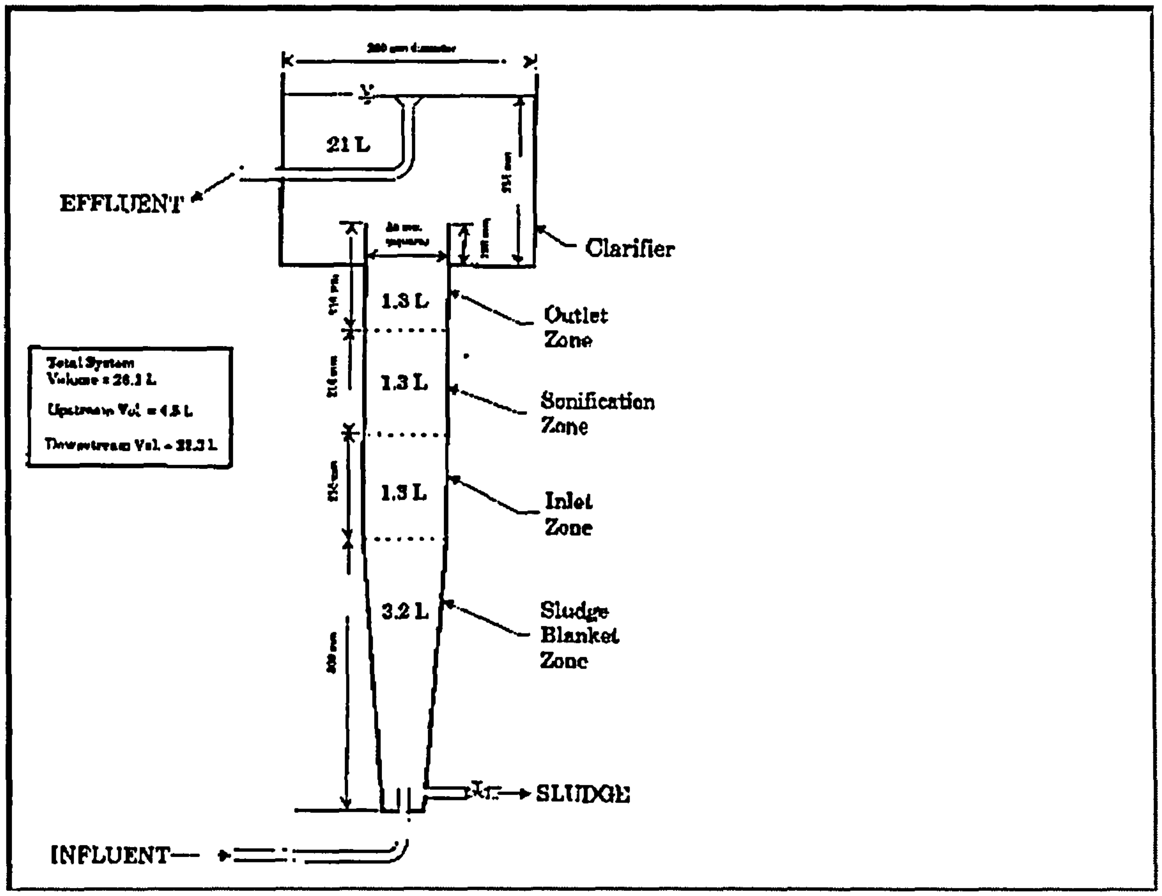
Sonofloc Process





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Sonofloc Process

20-Jan-98

Project: Welland River Project **Year: 93**

Location: Welland River, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr): 0.06 Amount Treated (Tonne): 0.2

Treatment Cost (US$):

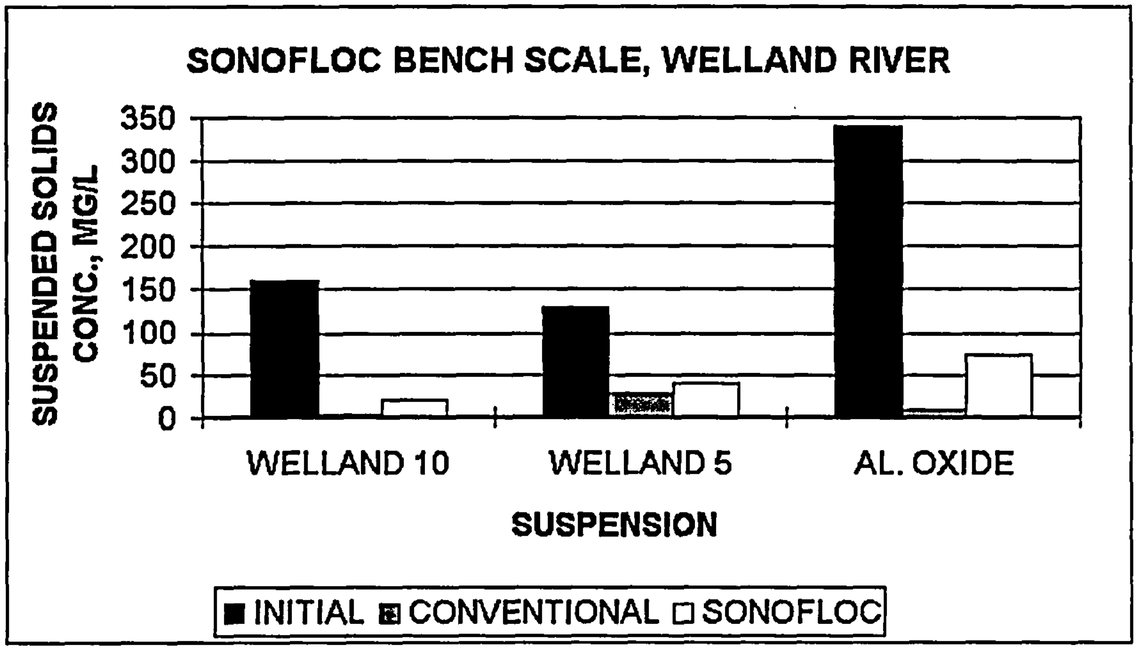
Setup Time (days): Breakdown Time (days):

Media Treated: Water with suspended sediment

Contaminants Treated: Suspended Solids; Bentonite Clay; Aluminum Oxide

Emissions/ByProducts: Clean water; sediment solids

Description: A number of suspensions were tested under the feasability test program. Non-sediment suspensions (aluminum oxide and bentonite clay) were tested in order to provide a baseline for comparision and to correlate results from this study with those performed in Austria. For sediment testing a suspension was fabricated from Welland River sediment. The principle performance parameter monitored was suspended solids, from which the separation efficiency of solids from liquids could be calculated. In all experiments conducted with the Sonofloc units suspended solids concentration was reduced.



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SRE Solv-Ex *20-Jan-98*

Technology Type: Metal Extraction, Organic Extraction TechID: 182

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

The key components of this process are a special non-toxic solvent system and a multi-stage countercurrent extractor. The special solvent system is a mixture of polar and non-polar components which help in breaking emulsions of oil, water and inorganic constituents. The system can handle sludges which are very wet including steel company, gas plant and refinery sludges.

The process consists of the pretreatment unit, the extractor, and the solvent fractionation train. The processor discharges a relatively non-hazardous stream of solids with less than 0.1% organics and a water stream containing organics dissolved in the lower ppm range. The organic phase containing the solvent and the contaminants from the extractor are distilled in the solvent fractionation train. The solvent system, recovered at a temperature less than 50 degrees Celsius, is recycled back to the process. The contaminants are collected for disposal.

Any effluent water or off-gases requiring further treatment can be handled by SRE's BIO-OX Water and Air Bioreactors, respectively. The bioreactors use an innovative spiral cartridge design that allows the contaminated streams to come in direst contact with the biofilm.

Limitations:

Efficiency Description: Sytems can reduce organic concentrations from 40% to less than 0.1%; Meets BDAT specs

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals No permits have been obtained to date

Setup/Feed: Setup Time (days): 5 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 8

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $20.00 – $35.00 Average Cost (US$/Tonne): $27.00

If contamination is light (as in dredging circumstances), instead of using solvent, a biological fluid (Bio-Ex) can be used for treatment. In this case the average cost per tonne would be $12.00.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Concentrated contaminants, treated solids, separated water (may require treatment, also available from SRE) and volatile air emissions (during handling of raw sludge, can be treated by SRE BIO-OX air bioreactor).

Developers:

SRE, Inc.
P.O. Box 251, 20 Chapin Road
Pine Brook, NJ
USA 07058-
Notes

Contact: Sofer, Sam
Phone: (201) 661-5192 Ext:
Fax: (201) 808-1242
Email:

Vendors:

Envirotec
1349 Green Lane
Chester Springs, PA
USA 19425-
Notes

Contact: Dobol, P.
Phone: (215) 469-1141 Ext:
Fax: (215) 469-0936
Email:

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRE Solv-Ex

20-Jan-98

Project: New York Steel Mill **Year: 95**

Location: , New York, USA

Commercial

Client/Funding Agency	Contact	Phone
Private		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Steel Mill Sludge

Contaminants Treated: Amount treated: several hundred thousand tons.

Emissions/ByProducts:

Description: Project continued into May 1996.

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SRS SAREX Chemical Fixation Process

20-Jan-98

TechID: 163

Technology Type: Stabilization/Fixation

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The SAREX CFP was developed for the petroleum industry. It utilizes a lime based reagent blend to detoxify organic contaminants and bind them in a soil-like chemically stable matrix through an exothermic reaction. The CFP improves leachate characteristics through chemical fixation, controlling free liquid content and reducing the surface area of the contaminated material. The CFP is applied either in an "open" system or "closed" system, differing only in the manner in which the contaminated matrix and reagents are handled. The latter is used when the release of hazardous fumes or vapours may occur.

Open system operations occur in a blending pit, in which reagents and contaminated material are mixed using an articulated backhoe. Reagents are added initially for neutralization. A second application of reagents provides the fixation. Curing time is typically 2 to 3 days.

A mobile trailer mounted processor is key to the enclosed system operation. Waste material is neutralized to prevent the occurrence of acid vapour emissions during processing and then fed to a homogenizer. Within the homogenizer, which consists of a single screw sealed continuous mixer, the waste is combined with the fixation reagents. The material exits the homogenizer, approximately 80 % processed, and drops into an indirectly heated, sealed and jacketed, multi-screw thermal processor. Curing is complete by the time the material exits the thermal processor. Vapours from both the homogenizer and thermal processor are collected and passed through the SAREX Vapour Recovery System (VRS) prior to discharge. The VRS is designed to remove particulates, water vapours and hydrocarbon vapours.

Limitations: Not for lead bearing wastes.

Efficiency Description: Meets toxicity characteristic leaching procedure (TCLP) standards.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals

Setup/Feed: Setup Time (days): 2 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): $65.00 – $85.00 Average Cost (US$/Tonne): $75.00

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Soil like processed solids, hydrocarbon and water vapour, wastewater

Developers:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Vendors:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Literature References:

Author: SITE Technology Profile
Title: Separation and Recovery Systems, Inc. (SAREX Chemical Fixation Process)
Journal: Date: Oct 1995

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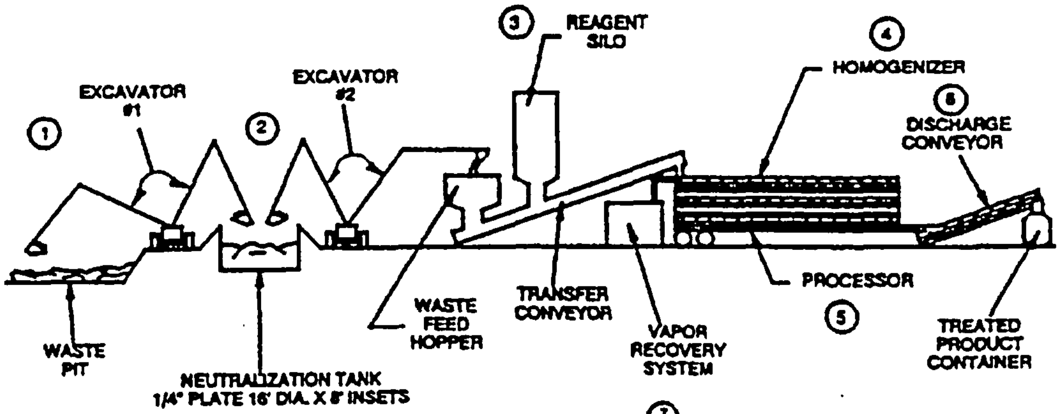
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRS SAREX Chemical Fixation Process



NOTES:
1. EXCAVATION/NEUTRALIZATION/VAPOR CONTROL
2. PRE-PROCESS BLENDING/NEUTRALIZATION
3. WASTE FEED TO PROCESSOR
4. HOMOGENIZING
5. PROCESSING
6. DISCHARGE CONVEYOR
7. VAPOR RECOVERY SYSTEM (vrs)

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SRS SAREX MX-1500 Centrifuge

20-Jan-98

Technology Type: Pre Treatment TechID: 164

Contaminants Treated: PAH's, Petroleum Hydrocarbons, Oil & Grease, BTEX

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The MX 1500 is a mobile trailer mounted unit designed to process watery, oily sludges generated within the petroleum industry. The process separates the water, oil and solids phases of input wastes primarily through the use of strainers and centrifuges. Heat, cutting oil, and polymer chemicals are used to condition the waste and optimize the process. The heat - 70 to 100 °C - improves material handling, liquid/solid separation and oil/water separation.

The waste, conditioned with emulsifiers if necessary, is fed through a strainer to remove the oversize solids prior to entry to a steam heated tank. The heated waste stream passes to a horizontal decanter centrifuge for the removal of the bulk of the solids. The resulting centrifuge cake may possess up to 45% solids. The water/oil mixture remaining is reheated, strained and pumped to a vertical centrifuge for oil water separation.

Vapours generated throughout the processing are collected and treated via the SAREX Vapour Recovery System (VRS). The VRS relies on condensation, water scrubbing and caustic scrubbing prior to passing through an activated charcoal bed before release to remove noxious and toxic vapours, if any. The off gases are continually monitored for hydrocarbon content.

The system requires electricity, steam under pressure and water for operation.

Limitations: Liquids and sludges only.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Approved by: EPA 40 CFR Part 264.1; California Department of Health Services Section 25143.2.; State of Texas Water Commission; Louisiana Dept. of Environmental Quality; State of Ohio DOE. US EPA recycling exemption.

Setup/Feed: Setup Time (days): 2.5 Breakdown Time (days): 3

Feed Rate Average (Tonne/hr): 30

Cost: Capital Cost (US$): $1,000,000.

Treatment Cost (US$/Tonne): $16.00 – $36.00 Average Cost (US$/Tonne): $22.00

Capital cost: 750,000 to 1,250,000.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Water (with up to 5% oil and solids), oil, dry solids, vapours ("clean")

Developers:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Vendors:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Literature References:

Author: **Miller, B.H., Sheehan, W.J., Swanberg, C.G., Matthys, P.**
Title: Waste Minimization and Resource Recovery Using Centrifugation and Thermal Desorption
Journal: Presented at International Symposium on Extraction and Processing for the Treatment and Minimization of Wastes Date: **Mar 1994**

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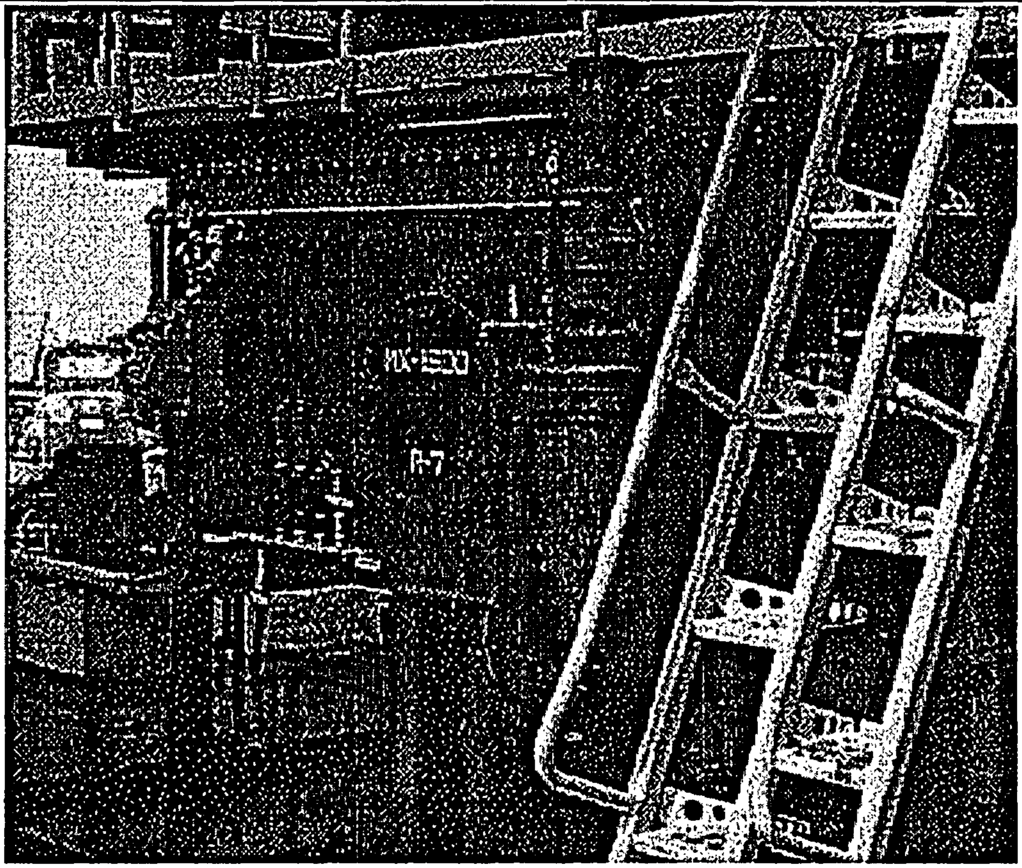
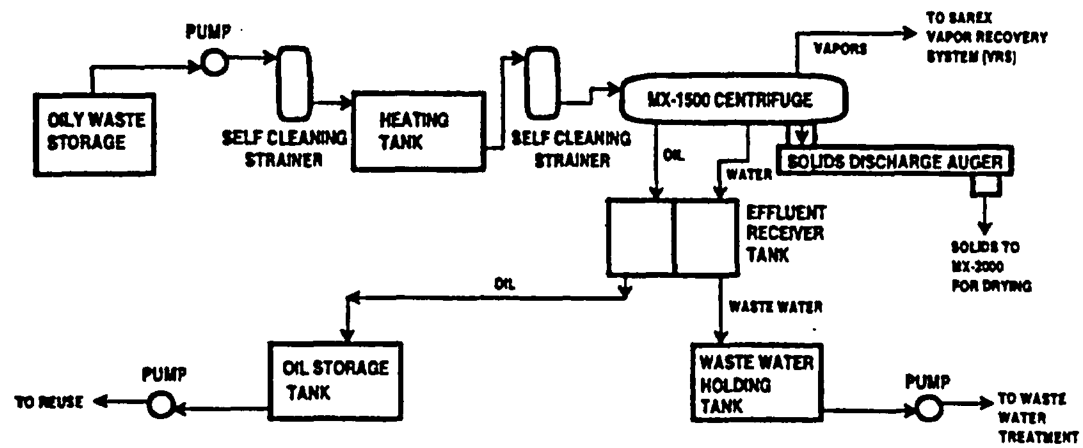
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRS SAREX MX-1500 Centrifuge

20-Jan-98





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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRS SAREX MX-1500 Centrifuge

20-Jan-98

Project: Louisiana Refinery — **Year: 95**

Location: , Louisiana, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Crude tank

Contaminants Treated: 85 % Oil; 10 % solid; 5 % water

Emissions/ByProducts:

Description: Amount treated: 45,000 BBLS.

Project: Kansas Superfund Site — **Year: 94**

Location: , Kansas, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Sludge ponds

Contaminants Treated: 15 % Oil; 8 % Solid; 77 % Water

Emissions/ByProducts:

Description: Amount treated: 350,000 BBLS.

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRS SAREX MX-2000 Thermal Dryer

20-Jan-98

TechID: 165

Technology Type: Thermal, Post Treatment, Pre Treatment

Contaminants Treated: VOCs, BTEX

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The MX-2000 was designed to treat VOCs and SVOCs by indirect thermal desorption of dewatered solids waste generated by the petroleum industry. It has the ability to process waste that is saturated, of fine texture and low permeability contaminated by both organic and inorganic compounds.

The key component in the process is a heated rotary Holo-Flite multiple screw and jacket assembly. Waste material is fed into the processor by a conveyor system. As the waste is moved through the processor by the auger, a heat transfer fluid is circulated through the hollow screw shaft to heat the waste. Steam is used to heat the waste to approximately 150 °C, but more often oil is used to allow the waste to be heated to as high as 350 °C. A residence time of 60 to 90 minutes is usually sufficient to desorb all VOCs and SVOCs from the waste.

The treated soil is discharged and sprayed with process water to cool and control dust. Vapours are collected from the processor and passed through the SAREX Vapour Recovery System (VRS). Within the VRS, vapours are condensed, scrubbed and passed through an activated charcoal bed prior to release to the atmosphere.

Limitations: Up to 10 tons per hour.

Efficiency Description: Removal of volatiles to non-detectable levels.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals May be exempt from permitting by qualifying as a totally enclosed loop recycling system that processes secondary materials as per U.S. EPAs 40 CFR Part 261.4(a)8.

Setup/Feed: Setup Time (days): 5 Breakdown Time (days): 5

Feed Rate Average (Tonne/hr): 6

Cost: Capital Cost (US$): $650,000.00

Treatment Cost (US$/Tonne): $50.00 – $85.00 Average Cost (US$/Tonne): $67.00

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean dry solids, oily water, liquid hydrocarbons, treated vapours

Developers:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Vendors:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Literature References:

Author: **Sheehan, W.J.**
Title: Thermal Desorption Utilizing Hollow-Screw Technology
Journal: Proceedings: 1992 Incineration Conference, May 11-15, 1992, Albuquerque, New Mexico, USA Date: **May 1992**

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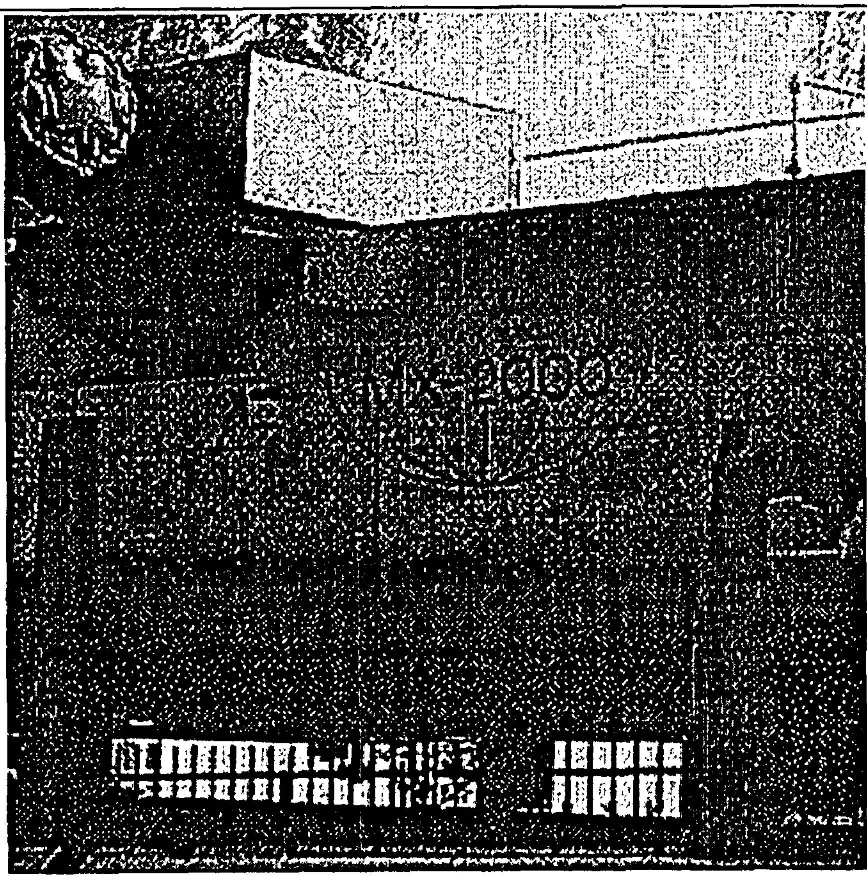

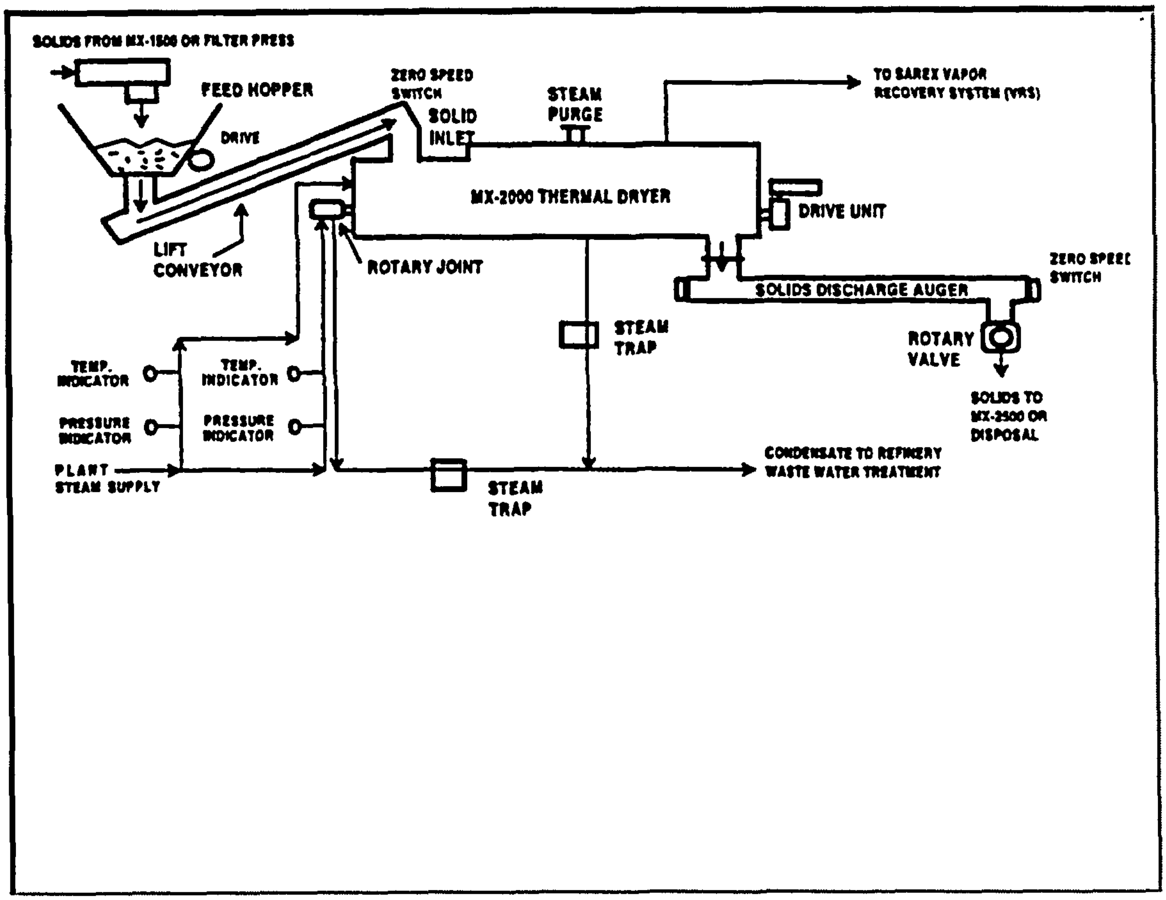

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SRS SAREX MX-2000 Thermal Dryer

20-Jan-98

Project: New Jersey Aerospace **Year: 94**

Location: , New Jersey, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 3000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Soils

Contaminants Treated: 2 % solvent

Emissions/ByProducts:

Description: Radioactive mixed waste.

Project: Kansas Superfund Site **Year: 94**

Location: , Kansas, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Superfund		

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge Ponds

Contaminants Treated: 15 % Oil; 8% Solid; 77% Water

Emissions/ByProducts:

Description: Amount treated 350,000 BBLS.

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

SRS SAREX MX-2500 B.D.A.T. Thermal Desorber

20-Jan-98

Technology Type: Thermal TechID: 166

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The SAREX MX-2500 is a transportable, medium temperature, electrically heated thermal screw processor that thermally desorbs semivolatile organics from sludge, sediments, or soils to levels below land disposal restriction (LDR) standards. The hollow-flite screws in the SAREX MX-2500 are indirectly heated to obtain solids temperatures of 300 to 500 °C.

The solids enter the SAREX MX-2500 through an air-tight conveyance system. The solids are processed through the MX-2500 in typically a nitrogen inerted environment. The treated soils exit the MX-2500 thermal desorber and are cooled in an air-tight, water cooled, screw conveyor system.

The vapors containing the desorbed organics exit the thermal processor and are treated to below regulatory standards using the SAREX vapor recovery system (VRS).

Limitations: 20% moisture (as H2O)

Efficiency Description: Typically achieve BDAT (US) standards

Government Funding: Superfund

Environmental Concerns: Stack monitoring for PCB wastes.

Health & Safety Plan Available: ☒

Regulatory Approvals Recycling exemption, various state air permits. i.e. United States (Ca., Ohio, N.J., La., Tx., Ok., Ks., Wa., N.C., N.M). Australia.

Setup/Feed: Setup Time (days): 1.5 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 0.5

Cost: Capital Cost (US$): $800,000.00

Treatment Cost (US$/Tonne): $180.00 – $260.00 Average Cost (US$/Tonne): $220.00

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean dry solids, water, condensed organics, treated vapours. Within air permit limits.

Developers:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Vendors:

Separation and Recovery Systems, Inc.
1762 McGaw Avenue
Irvine, CA
USA 92714-4962
Notes

Contact: Sheehan, B.
Phone: (714) 261-8860 Ext:
Fax: (714) 261-6010
Email:

Literature References:

Author: Swanberg, C.
Title: MX-2500 Thermal Processor for Treatment of Petroleum Refining Wastes and Contaminated Soils
Journal: American Institute of Chemical Engineers Date: Aug 1992

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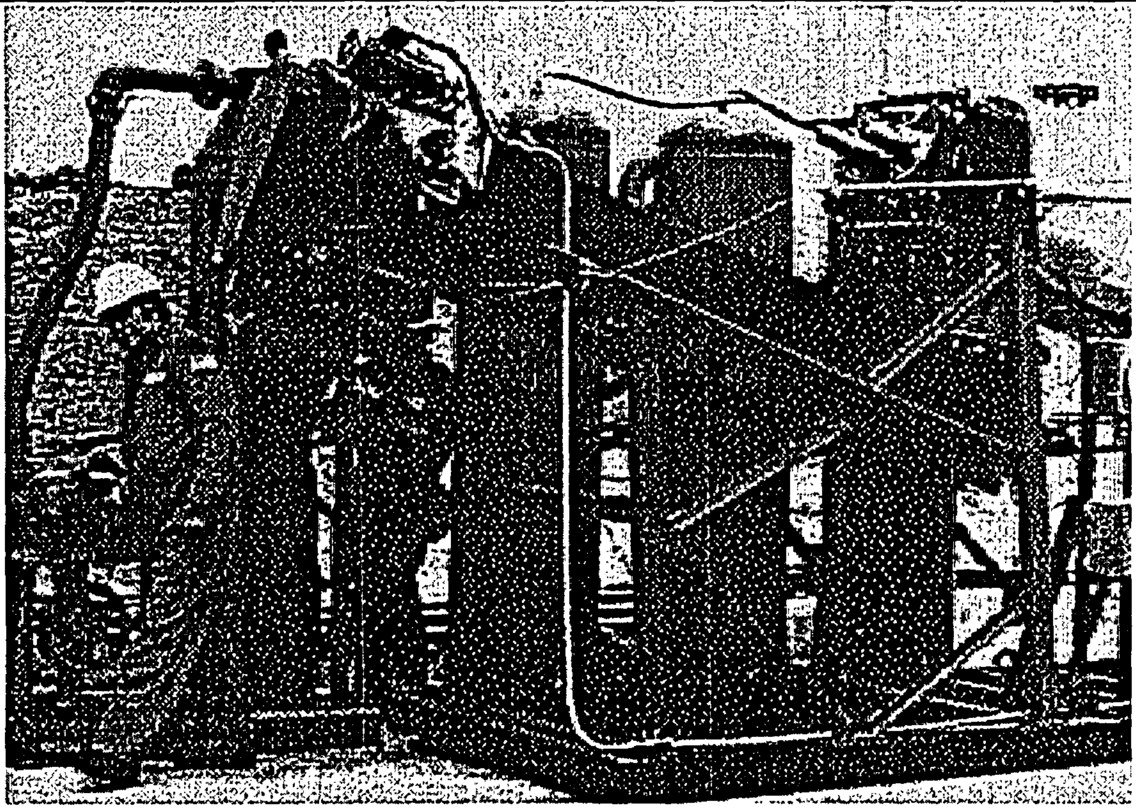
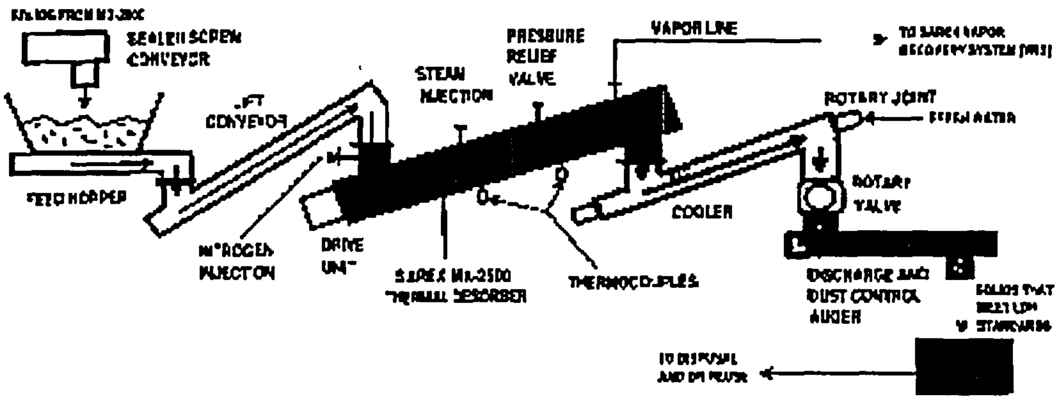
SRS SAREX MX-2500 B.D.A.T. Thermal Desorber

20-Jan-98





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Steffen Robertson & Kirsten, Froth Flotation

20-Jan-98

Technology Type: Metal Extraction TechID: 363

Contaminants Treated: Oil & Grease, Heavy Metals

Media Treated: Sediment Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

Froth flotation is one of the most common processes used for separating selected mineral phases form ore. In simple terms, forth flotation requires three steps:

* Grinding and wetting the ore to produce a slurry.
* Addition of reagents to render the target mineral phase hydrophobic and remove it to a floating "froth".
* Separation of the froth from the slurry by skimming of the slurry surface.

The process relies on differences in the hydrophobic characteristics of mineral surfaces. The differences are enhanced or suppressed by the addition of surfactant reagents, which also serve to collect and trap air bubbles. The trapped air bubbles allow the surfactant-bound mineral to float, forming a "froth" on the suface of the slurry. The froth is then separated from the slurry to yield a concentrated mineral phase.

The available reagents can be categorised into three broad groups: collectors, frothers, and regulators. Collectors are sufactants that adhere to specific mineral surfaces, rendering them hydrophobic and leading to the formation of a froth. Frothers increase the stability of the froth phase, in order to prevent return of the floating mineral to the slurry. Regulators either activate or supress adhesion of surfactants (collectors) to mineral phases, and are used to control the floatation process.

A combination of reagents is generally required to selectively remove a target mineral phase form the slurry. For example, reagent combinations suitable for removing sulphide phases are often used in ore processing. In some cases, a preliminary treatment to convert oxide phase surfaces to sulphidic form is required. Alternatively, the reagent combination can be selected to float silicate phases, leaving the metal-rich oxide and sulphide phases behind.

Limitations: Fine grained sediment fraction needs further treatment after froth flotation.

Efficiency Description: Can reduce metal concentrations in the larger particle sizes by over 90%.

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Fine grained sediment (froth) is heavily contaminated.

Developers:

Steffen Robertson & Kirsten
Suite 800, 580 Hornby Street
Vancouver, BC
Canada V6C3B6
Notes

Contact: Hockley, Daryl
Phone: (604) 681-4196 Ext:
Fax: (604) 687-5532
Email:

Literature References:

Author: **Chapman, J.T., Hockley, D.**
Title: Welland River Sediments: Application of Froth Flotation and Wet High Intensity Magnetic Separation to Sediment Clean-up
Journal: Prepared for Contaminated Sediment Treatment Technology Program' Date: Sep 1994

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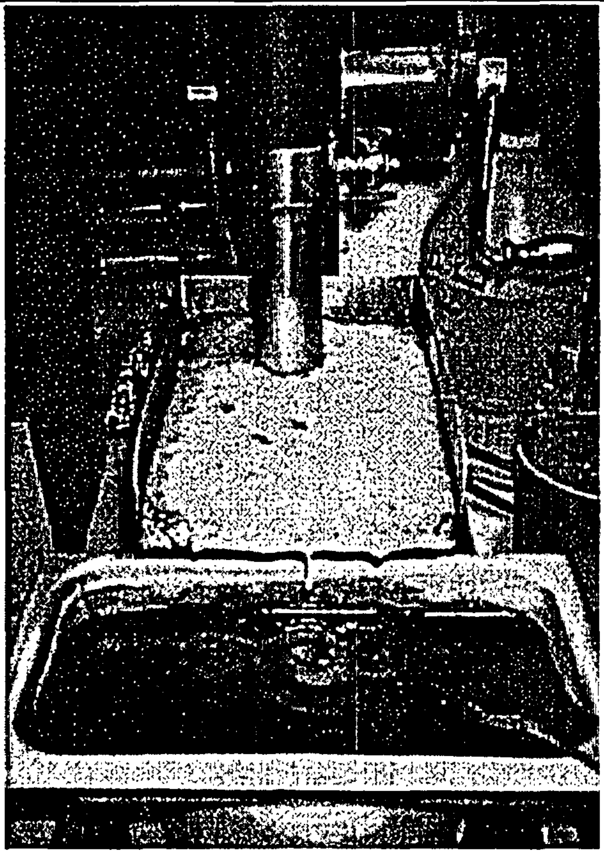
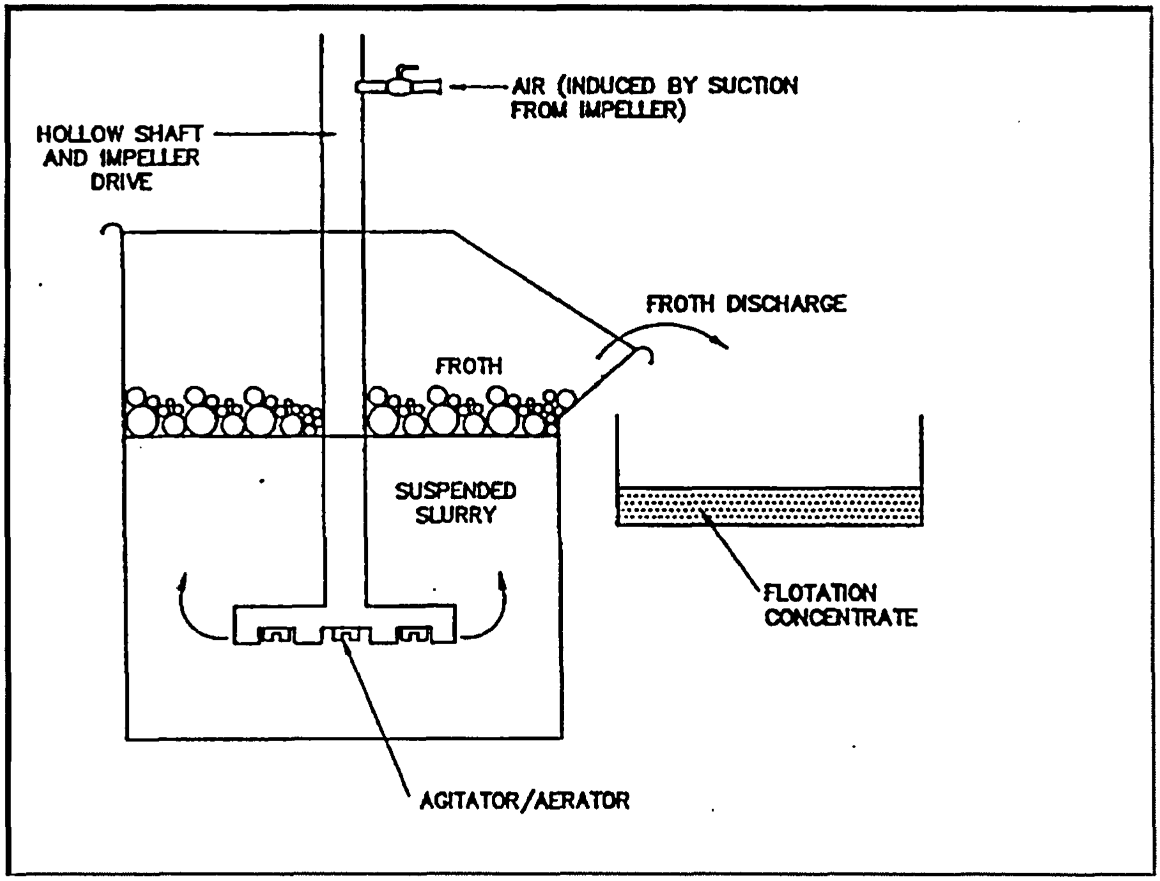
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Steffen Robertson & Kirsten, Froth Flotation

20-Jan-98





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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Steffen Robertson & Kirsten, Froth Flotation

20-Jan-98

Project: Welland River Project **Year: 94**

Location: Welland, Ontario, Canada

Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: The sediment used in this study was the so-called "reef" sediment as characterized in a previous study (Acres International Ltd., 1992). Inspection of the sediment indicated that it was very heterogenous in composition; metallic particles were clearly evident.

Contaminants Treated:

Compound	Untreated Levels (ug/g)
Oil & Grease	16,000
Chromium	45,000
Copper	10,000
Lead	2,000
Zinc	4,000
Nickel	75,000
Manganese	70,000
Iron	43

Emissions/ByProducts:

Description: Treatability Study:

The objective of this investigation was to test the ability of technology common in the mineral industry to separate contaminated phase from sediment. Two treatment processes were investigated: froth flotation and wet high intensity magnetic separation (WHIMS)

Prior to flotation testing, it was decided to remove as much as possible of the oil and grease. The froth flotation of the oil and grease and affected particles was aided by the addition of a frothing agent to allow the formation of a stable froth. A "Metal Sulphide Flotation" test and a "Silicate Flotation" test were done. (For the second part of project, see Steffen Robertson & Kirsten, Wet High Intensity Magnetic Separation - Welland Project).

RESULTS

Metal Sulphide Flotation: Only a small mass of material was removed by the metal sulphide flotation. It is surmised that the poor results were due to the oil and grease which was not effectively removed from the metal surfaces in the pre-treatment.

Silicate Flotation: This method separated more than the the sulphide flotation, but results were still poor. Again, this is most likely due to oil & grease fouling of particle surfaces. In addition, a large portion of the metal contamination in this sediment is in particulate form. It is likely that the froth was not able to float these particles and they remained in the tailings.

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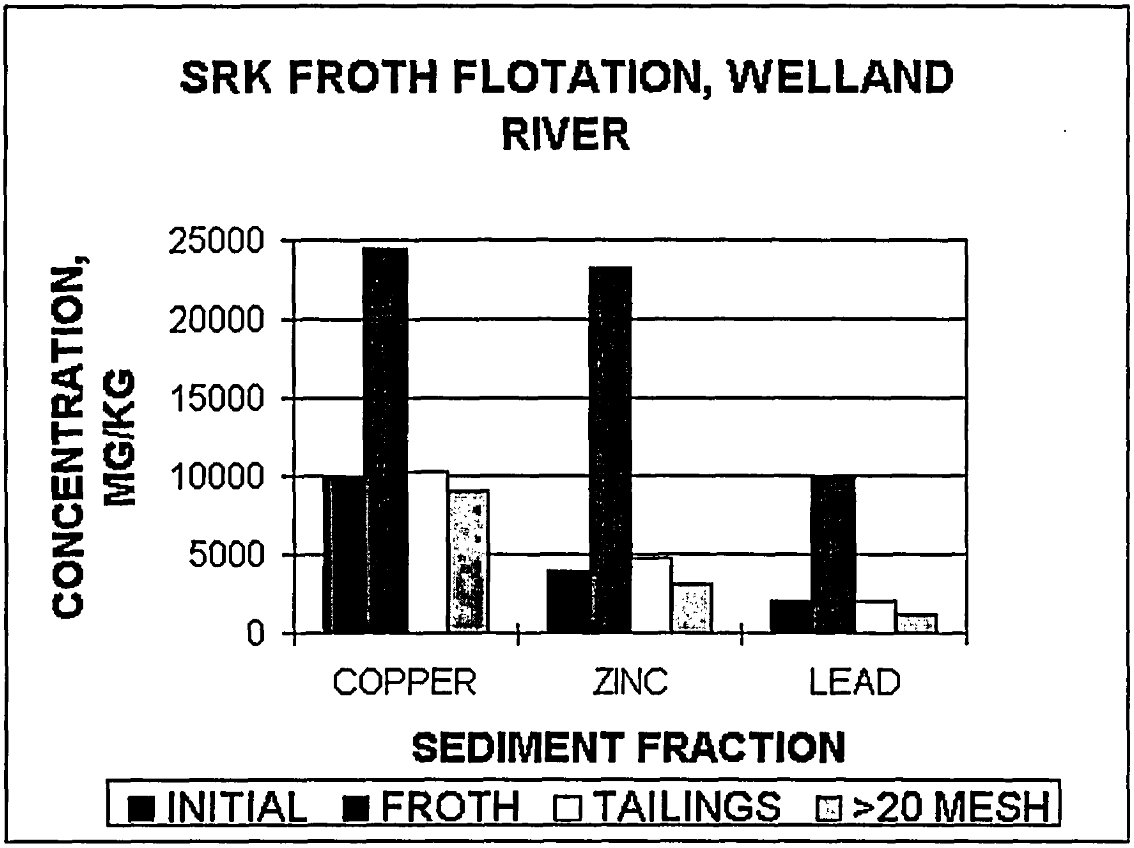

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Steffen Robertson & Kirsten, Wet High Intensity Magnetic Separation (WHIMS)

20-Jan-98

TechID: 362

Technology Type: Metal Extraction

Contaminants Treated: Oil & Grease, Heavy Metals

Media Treated: Sediment Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** Canada **Portable:** ☐

Description:

Magnetic separators are used in many applications, including solid waste treatment and waste stream reduction. The magnetic separators in most common use are "low intensity", employing magnetic field strengths of less than 1 kGauss. In the mineral processing industry, Wet High Intensity Magnetic Separation (WHIMS) is commonly uses to upgrade low-grade iron ores. The process consists of four steps:

* Grinding and wetting the ore to produce a slurry;
* Passing the slurry through a matrix of small iron spheres, held within a high intensity magnetic field;
* Washing the iron sphere matrix to remove any non-magnetic material; and
* Removing the iron sphere matrix from the magnetic field to release the high grade iron ore.

In comparison to other magnetic separation methods, WHIMS has several advantages. First, the use of iron spheres within the slurry shortens the path that particles must take to reach the magnetic surfaces. Second, the use of wet separation avoids the problems typically associated with dry processes, such as agglomeration of magnetic and non-magnetic particles resulting in dilution of the magnetic fraction. Third, the use of high intensity magnetic fields makes the process suitable for very small particulate matter, to less than 5μm in size.

In typical operations, the WHMIS requires a high intensity electromagnet that is used to induce a magnetic field around a matrix of small iron spheres. The matrix is transported into and out of the magnetic field on a conveyor belt. The slurry is contacted with the matrix for part of its passage through the magnetic field. Before the matrix leaves the magnetic field, it is washed with low pressure water to remove any captured non-magnetic particles from the matrix. These particles are typically collected as a middling concentrate which is then re-treated. The matrix then carries the magnetic fraction out of the magnetic field where it is washed with high pressure water to collect the magnetic concentrate.

Limitations: Only useful for removing particulate magnetic metals (mainly iron).

Efficiency Description: Efficiency is highly dependent on the nature of the contaminants and sediment.

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: The only product is a recyclable magnetic metal fraction.

Developers:

Steffen Robertson & Kirsten
Suite 800, 580 Hornby Street
Vancouver, BC
Canada V6C3B6
Notes

Contact: Hockley, Daryl
Phone: (604) 681-4196 Ext:
Fax: (604) 687-5532
Email:

Literature References:

Author: Chapman, J.T., Hockley, D.
Title: Welland River Sediments: Application of Froth Flotation and Wet High Intensity Magnetic Separation to Sediment Clean-Up
Journal: Prepared for Contaminated Sediment Treatment Technology Program Date: Sep 1994

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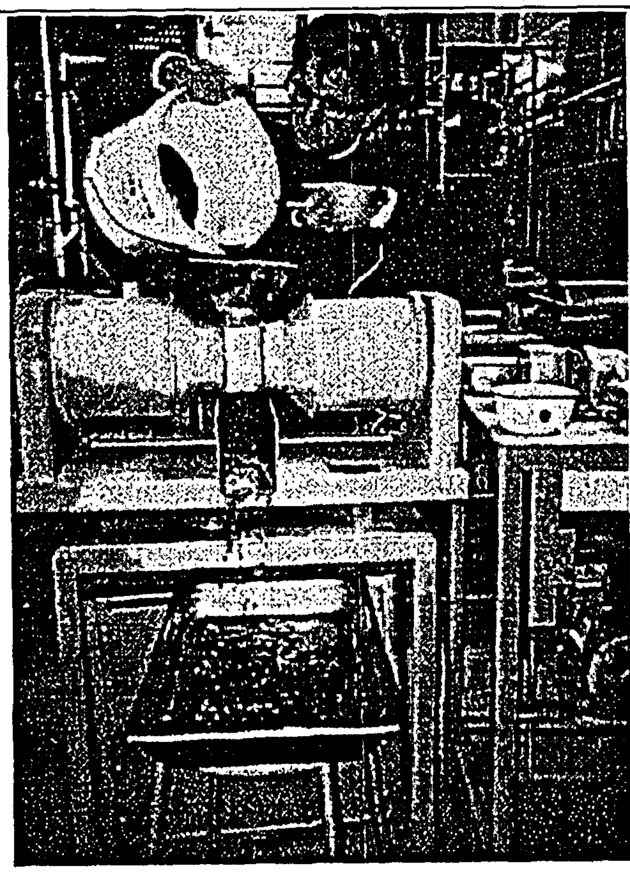

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Steffen Robertson & Kirsten, Wet High Intensity Magnetic Separation (WHIMS) *20-Jan-98*

Project: Welland River Project **Year: 94**

Location: Welland, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: The sediment used in this study was the so-called "reef" sediment as characterized in a previous study (Acres International Ltd., 1992). Inspection of the sediment indicated that it was very heterogenous in composition; metallic particles were clearly evident.

Contaminants Treated:

Compound	Untreated Levels (ug/g)
Oil & Grease	16,000
Chromium	45,000
Copper	10,000
Lead	2,000
Zinc	4,000
Nickel	75,000
Manganese	70,000
Iron	43

Emissions/ByProducts:

Description: Treatability Study:

The objective of this investigation was to test the ability of technology common in the mineral industry to separate contaminated phase from sediment. Two treatment processes were investigated: froth flotation and wet high intensity magnetic separation (WHIMS).

The solids were first fed to a Sala wet low intensity magnetic separator. The non-magnetic product was then fed to a Carpco wet high intensity magnetic separator. This separator has an electromagnet which can be controlled to vary the magnetic field strength. The low intensity non-magnetic product was passed through the separator using a field strength of approximately 2.5 Kgauss to produce a paramagnetic product. The non-magnetic fraction from the 2.5 Kgauss was then re-fed to the separator with the field strength set at approximately 15 Kgauss. (For first part of project, see Steffen Robertson & Kirsten, Froth Flotation - Welland Project).

RESULTS

The low intensity method removed a large fraction of the sample. The non-magnetic portion comprised only 1.1% of the total mass. Also, the non-magnetic fraction, although low in total mass, was significantly less contaminated than the other fractions. It is interesting to note that metals such as chromium and copper report to the magnetic fraction. The indication is that those metals are intimately associated with iron, probably as alloys. As a consequence, separation of the individual metals would be extremely difficult.

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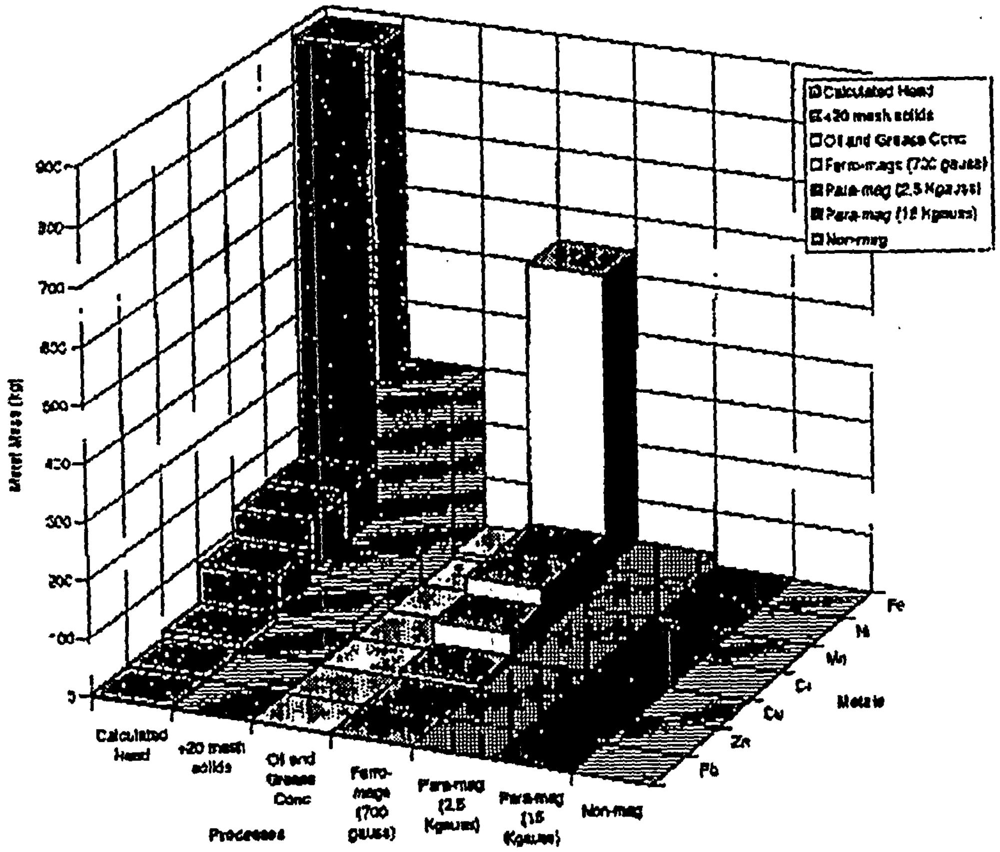

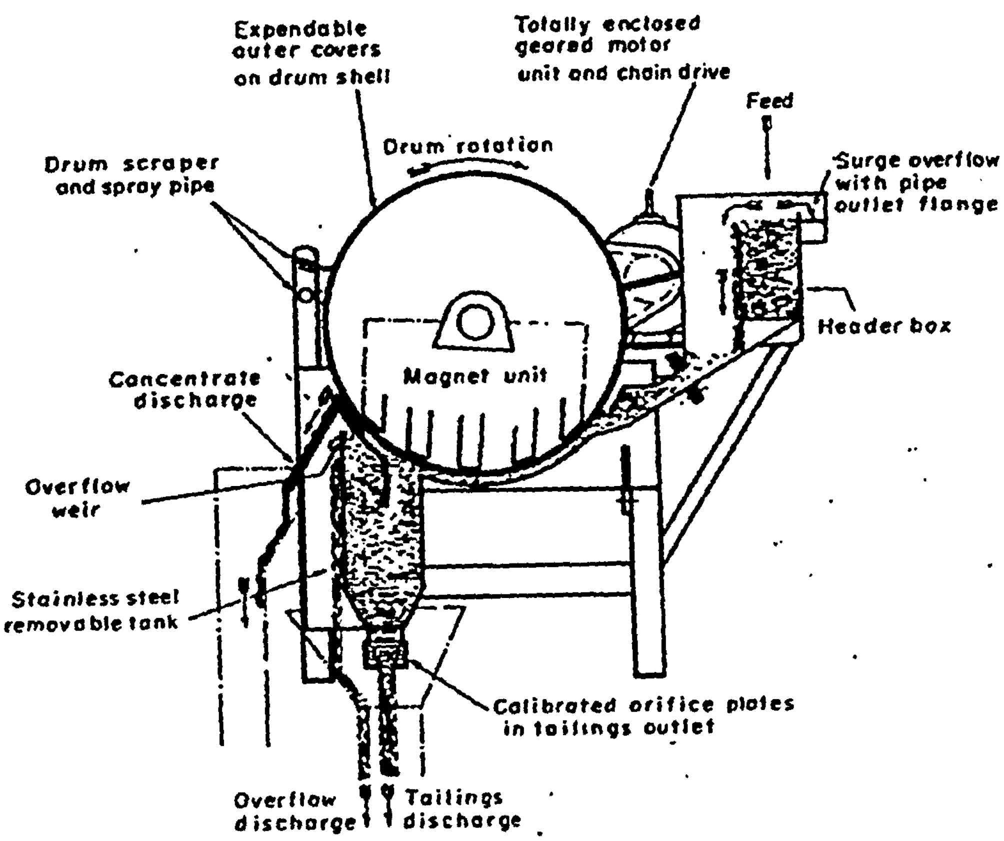

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Tallon Vitrokele Soil Remediation Technology

20-Jan-98

Technology Type: Metal Extraction, Organic Extraction   TechID: 210

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Mercury

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial   **Country Of Origin:** Canada   **Portable:** ☒

Description:

Tallon's technology employs an integrated combination of standard physical, organic and hydrometallurgical systems to mechanically and chemically process and de-toxify contaminated soils or liquids. Metals are solubilized by agitated leaching and recovered with a mixed function VITROKELE adsorbent which is capable of binding (removing) a range of toxic metals while providing a simple chemical elution of metal (recovery). Organic contaminants are removed byflotation and sediment washing.

The VITROKELE consists of high affinity chelating groups attached to a macro-reticular polystyrene substrate and exhibits resistance to chemical fouling and chemical/physical attrition. Use of VITROKELE enables a wide range of inexpensive, non-toxic, non-persistant leaching agents to be used.

The VITROKELE technology has been applied in the metal plating and mining industries.

A number of U.S. Patents relating to the VITROKELE process have been obtained and additional patents are pending:
U.S. Patent 4,654,322 (March, 1987)
U.S. Patent 4,530,963 (July, 1985)
U.S. Patent 4,585,559 (April, 1986)
U.S. Patent 4,626,416 (December, 1986)

Limitations: May have difficulty with complex mixtures of metals in sediment.

Efficiency Description: 99.9% of leachable metals; 95% of recoverable non-volatiles

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Has been approved at commercial scale for a project in Quebec

Setup/Feed: Setup Time (days): 20   Breakdown Time (days):

Feed Rate Average (Tonne/hr): 16

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $40.00 – $110.00   Average Cost (US$/Tonne): $75.00

Database References: ATTIC ☐   VISITT ☐

Emissions / By-Products: no emmissions

Developers:

Tallon Metal Technologies Inc
Unit 4, 67 Watson Road, South
Guelph, Ontario
Canada   N1H 6H8

Contact: Holbein, B.
Phone: (519) 766-9160   Ext:
Fax: (519) 766-9170
Email:

Notes

Literature References:

Author: **Tallon Metal Technologies Inc.**
Title: Bench-Scale Treatability Study with Hamilton Harbour Sediments: Final Report
Journal: Prepared for Great Lakes Cleanup Fund   Date: Nov 1993

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Developed by the Wastewater Technology Centre
Operated by Water Technology International Corporation

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Tallon Vitrokele Soil Remediation Technology

20-Jan-98

Project: Hamilton Harbour Project **Year: 92**

Location: Hamilton, Ontario, Canada Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund, (COSTTEP)	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

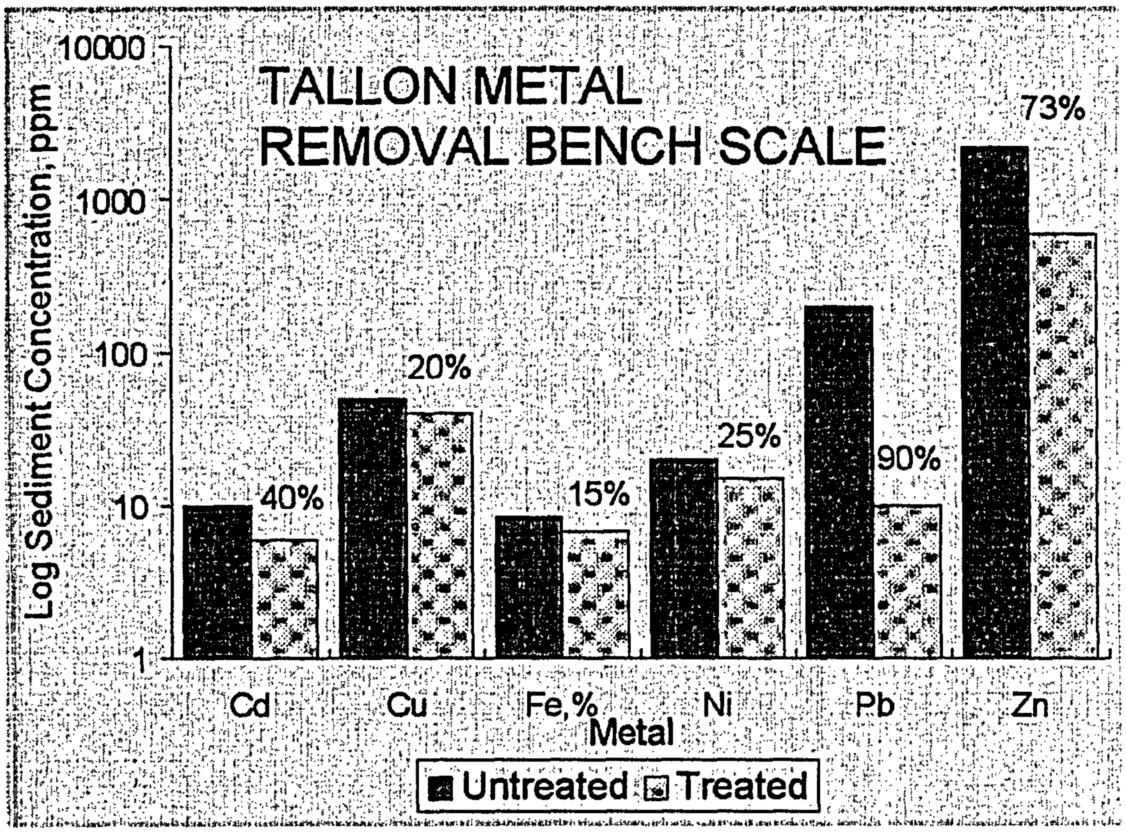
Media Treated: Sediment. Tar-like in appearance and smell, indicating that it contained coal tar (PAH). Size analysis revealed that the sediment was relatively fine in nature with approximately 92% of the total mass of a size less than 100 μm and 75% of the total mass less than 50 μm particle size.

Contaminants Treated: The Hamilton Harbour sediment was found to be significantly contaminated with heavy metals, exceeding the severe effect limits in the case of Cd, Cr, Fe, Mn, Ni, Pb and Zn. Analysis for organic contaminants revealed a high content of organic material in the sediment. Total organic carbon exceeded 10% (w/w) for the sediment with total oil & grease exceeding 1% (w/w).

Emissions/ByProducts:

Description: Bench Scale Treatability Study
A principle objective of the present study was to assess the potential for Tallon's technology for the combined heavy metal and organic contaminant removal from the sediment. It was concluded that a treatment approach exclusive to organic or inorganic contaminant removal would present process limitations and be less cost effective than an integrated treatment approach.
The Figure shows the treatment approach taken for the sediment. Organic recovery was performed by a flotation technology adapted to organic recovery by Tallon. Separation by flotation is achieved on the basis of surface charge characteristics of the particles treated. Both organic-selective and metal-selective flotation separation and recovery possibilites were assessed for the sediment.

Cost Estimate:
Based on other commercial scale and demonstration scale projects where Tallon has applied its technology it can be estimated that overall treatment costs would be in the range of $75 to $100 per tonne, assuming in excess of 20,000 tonnes of sediment was treated.



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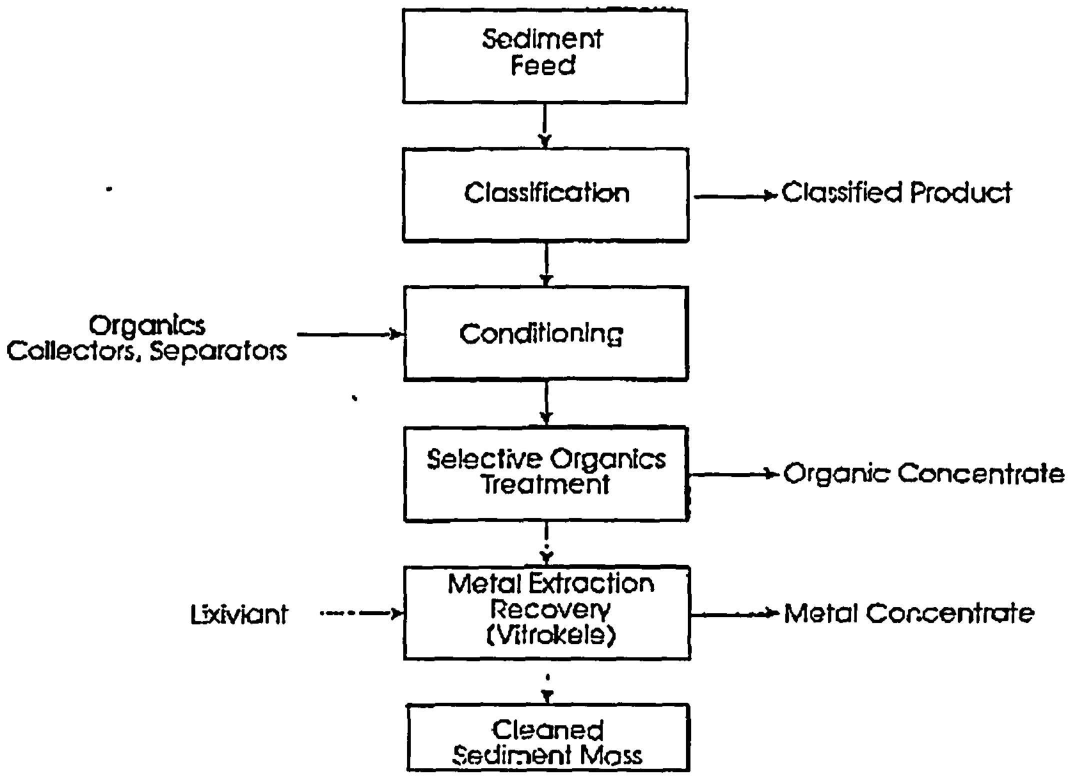
Tallon Vitrokele Soil Remediation Technology



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Terra-Kleen Soil Restoration Unit

20-Jan-98

TechID: 189

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The Soil Restoration Unit is a mobile solvent extraction system contained in two trailers. A number of solvents are used individually or in combinations to solvate a range of organic contaminants. The extraction is performed, assisted by heat, in a slurry reactor. Distillation is applied to recover the solvents and contaminants.

Limitations: The soil restoration unit may be used with moisture content in the soil as high as 70 %, but the higher moisture content will adversely affect remediation costs.

Efficiency Description: Variable according to site needs. Generally > 95%

Government Funding: SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals In permit process for US Toxic Substances Control Act (TSCA) Destruction Permit (PCB's)

Setup/Feed: Setup Time (days): 5 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.6

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $160.00 – $640.00 Average Cost (US$/Tonne): $400.00

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: Clean soil, condensed organics

Developers:

Terra-Kleen Corporation
7321 North Hammond Avenue
Oklahoma City, OK
USA 73132-

Contact: Cash, A. B.
Phone: (405) 728-0001 Ext:
Fax: (405) 728-0016
Email:

Notes

Literature References:

Author: **Terra-Kleen Corporation**
Title: Research & Development Test of the Terra-Kleen Soil Restoration Unit
Journal: TSCA Freedom of Information Act Date: **Jan 1991**

Author:
Title: News Article
Journal: Haz Tech News, Vol. 6, No. 8, p. 57 Date: **Apr 1991**

Author: **Cash, Robertson, Laguros**
Title: Solvent Extraction for the Remediation of Soils
Journal: Environmental Geotechnology, Usman & Acar, Balkemam, Rotterdam Date: **May 1992**

Author: **Cash, A.B.**
Title: Removal of Chlorinated Pesticides from Soil
Journal: I&ED Symposium, American Chemical Society Date: **Sep 1993**

Author: **Cash, A.B.**
Title: Full Scale Solvent Extraction Remedial Results
Journal: I&ED Symposium, American Chemical Society Date: **Sep 1993**

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Terra-Kleen Soil Restoration Unit

Project: Terra-Kleen Shop **Year: 91**

Location: Okmulgee, Oklahoma, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
Terra-Kleen	Alan Cash	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Traband PCB Site **Year: 91**

Location: Tulsa, Oklahoma, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Evans Electric Motors	Bob Evans	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Slag

Contaminants Treated:

Contaminants	Untreated:	Treated:
PCB's	5 ug/g	100 ug/g

Emissions/ByProducts:

Description:

Project: Electrical Substation **Year: 90**

Location: Sand Springs, Oklahoma, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA TSCA Division	Mr. Hiroshi Dodohara	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Slag

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Pinette Salvage Yard **Year:**

Location: Washburn, Maine, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
US EPA - RREL	Mark Meckes	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 100

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

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~~Emissions/ByProducts:~~

Description:

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Terrateam Composting Biotreatment

20-Jan-98

TechID: 195

Technology Type: Biological

Contaminants Treated: Petroleum Hydrocarbons

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Norway **Portable:** ☒

Description:

Soil or sediment with organic biodegradable contaminants are sorted and crushed. The homogenized material is mixed with a substrate (e.g. pine bark), necessary nutrients, and dispersant if necessary. The material is placed in windrows with optional forced aeration and provisions for collection and treatment of any leachate. Soil moisture, temperature, and nutrient concentration, as well as soil gas O2 and CO2 are monitored. Contaminant concentrations (e.g. PAH) are also controlled.

Limitations:

Efficiency Description: Tests with PAHs as contaminant: 1-10 mg/kg total PAH in treated soil

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Norwegian EPA concession pending

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.4

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $180.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Tillable soil suitable for landfill cover, roadside landscaping, or other limited access soil cover

Developers:

Aquateam - Norwegian Water Technology Centre A/S
P.O.Box 6326 Etterstad
Oslo,
Norway 0604 -
Notes

Contact: Berg, J. D.
Phone: 47-22-67 93 10 Ext:
Fax: 47-22-67 20 12
Email:

Vendors:

Terrateam - Norwegian Environmental Tech. Centre
P.O.Box 344
MO I RANA,
Norway 8601 -
Notes

Contact: Selfors, H.
Phone: 47-87-52 790 Ext:
Fax: 47-87-55 688
Email:

Literature References:

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Texarome Process

20-Jan-98

TechID: 106

Technology Type: Metal Extraction, Organic Extraction

Contaminants Treated: VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Texarome's continuous desorption process was designed and is operated commercial to obtain oils for the perfumes industry. Its application to hazardous waste is in the development stage through the U.S. EPA SITE Program. Further commercial development will occur with cooperative ventures.

The process uses highly superheated steam (up to 500 °C) as a conveying and stripping gas in a "pneumatic" type system to treat contaminated solids. The superheated steam as the carrier gas serves to vaporize the volatile and semi-volatile substances present in the solids.

An elaborate and proprietary way of running the pipes within the conveying system allows for a true counter-current flow, as well as a multi-stage dispersion and separation of the gas phase and the solid phase, to make the efficient mass transfer separation task possible.

After desorption of volatile substances from the solids, the various streams are separated for recovery. The treated solids are separated from the gas through cyclones and subjected to a final pass in the reactor loop before quenching and discharge. The gas, consisting of steam and VOCs, is condensed. The non-miscible VOCs are removed in coalescing decanters and packaged or used as boiler fuel. The water is treated for disposal or recycled as boiler feedwater.

Although non-volatile metals are not separated by the process a stabilization agent or reactants can be added in the final loop for treatment puposes. Similarly, trace compounds can be eliminated in the quenching stage with various aqueous solutions.

Limitations:

Efficiency Description: 99.9%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Accepted into the U.S. EPA SITE Demonstration Program in June 1991

Setup/Feed: Setup Time (days): 10 Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.2

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Pilot process therefore cost information not available at this time.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Not applicable

Developers:

Texarome Inc.
P.O. Box 157
Leakey, TX
USA 78873-
Notes

Contact: Boucard, Gueric
Phone: (210) 232-6079 Ext:
Fax: (210) 232-5716
Email:

Literature References:

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Thermo Design Engineering Ltd., Clean Soil Process

20-Jan-98

Technology Type: Organic Extraction, Pre Treatment, Soil Washing/Volume Reduction
Adsorption

TechID: 7

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, VOCs, Halogenated Organics, BTEX
Organic solids

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☒

Description:

The Clean Soil Process is a waste reduction and recycling technology. It is a soil washing technique that utilizes coal (or other carbonaceous substances) to remove/adsorb contaminants. In this process, soil and proportioned amounts of finely crushed coal and water are mixed together and heated to temperatures up to 99 °C. Coal with adsorbed contaminants is subsequently separated from washed coarse and fine grained soil. The products from the process are clean soil (coarse and fine grained) that can be recycled via solid fuel combustion facilities. The process can be used to clean soils contaminated with a wide variety of contaminants including petroleum and coal derived hydrocarbons (tars, heavy oils, fuel oils), PAH's, PCB's and heavy metals. The process effectively cleans soil containing VOC's (BTEX) which are removed during the mixing/heating stages, as well as MGP soils containing tar-saturated coke and slag.

The process can accept variable levels of contaminant concentration in the feed soil and can handle soils over a wide range of particle sizes. Typical soluble organics concentration in the feed soil can range from a few thousand ppm to 5% or higher by weight. Achievable residual contaminant levels in the clean soil are <500 ppm soluble organics, <50 ppm PAH and <10 ppm total VOC. Reduction of heavy metals is up to 90%. The coal-based solid fuel is non-hazardous in accordance with EPA regulatory levels as determined by toxicity characteristic leaching procedure (TCLP) analysis for volatiles, semi-volatiles and heavy metals.

Limitations: Solid feed with high clay content is difficult to treat.

Efficiency Description: >99.0 % has been achieved. Typical removal efficiencies are in the range 75-90%.

Government Funding: Great Lakes Cleanup Fund

Environmental Concerns: The disposal of coal may be a problem in some jurisdictions.

Health & Safety Plan Available: ☐

Regulatory Approvals Report currently under development to address Canada/United States regulatory status

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $25.00 – $35.00 Average Cost (US$/Tonne): $30.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Cleaned soil - mineral matter stream, and coal agglomerate - organic matter stream

Developers:

Alberta Research Council
1 Oil Patch Drive
Devon, Alberta
Canada T0E1E0
Notes

Contact: Ignasiak, L.
Phone: (403) 987-8783 Ext:
Fax: (403) 987-5280
Email:

Vendors:

Thermo Design Engineering Ltd.
1624-70 Ave., P.O.B. 5557, Postal St. "L"
Edmonton, AB
Canada T6C4E9
Notes

Contact: Rojek, Tony
Phone: (403) 440-6064 Ext:
Fax: (403) 440-1657
Email:

Literature References:

Author: **Ignasiak, T., Szymocha, K., Carson, D., Ignasiak, B.**
Title: Development of Clean Soil Technology using Coal as Oily/Tarry Contaminant Removal
Journal: EPRI Proceedings - 15th Annual EPRI Conference on Fuel Science Date: **Jun 1990**

Author: **Ignasiak, T., Szymocha, K., Kramer, J., Ignasiak, B.**
Title: Clean-up of Contaminated Soils using Coal as Contaminant Collector
Journal: Proceedings, 1991 International Conference on Coal Science Date: **Sep 1991**

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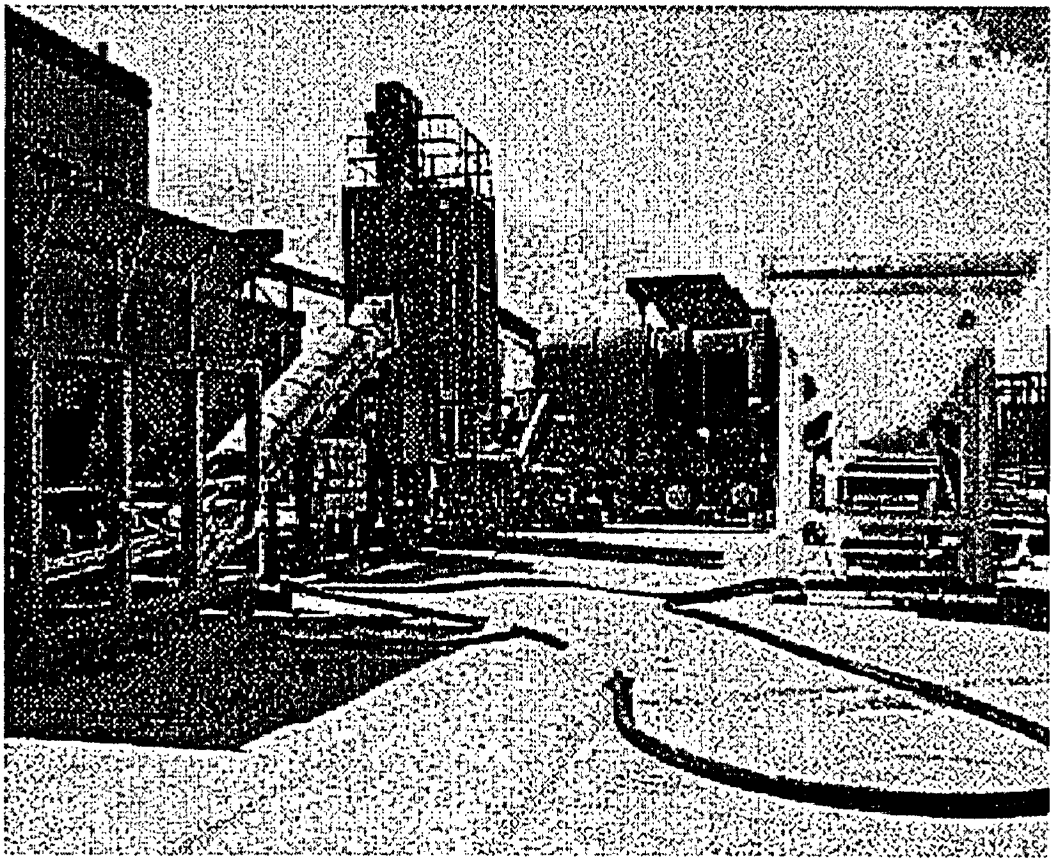
Thermo Design Engineering Ltd., Clean Soil Process

~~Date: Sep 1991~~ 20-Jan-98

Author: **Alberta Research Council : Coal and Hydrocarbon Processing**
Title: Final Report: Bench Scale Studies Hamilton Harbour Sediments : Contract No. 1-6021
Journal: Prepared for Great Lakes Cleanup Fund   Date: **Mar 1992**

Author: **Wastewater Technology Centre**
Title: ARC/EPRI Clean Soil Process Bench Scale Demonstration
Journal: Great Lakes Cleanup Fund Fact Sheet Number 4   Date: **Sep 1992**

Author: **Ignasiak, T., Szymocha, K., Pawlak, W., Ignasiak, L., Kramer, J.**
Title: Application of Coal-Oil Agglomeration for Soil Clean-up
Journal: Proceedings: Processing of Hydrophobic Minerals and Fine Coal   Date: **Aug 1995**



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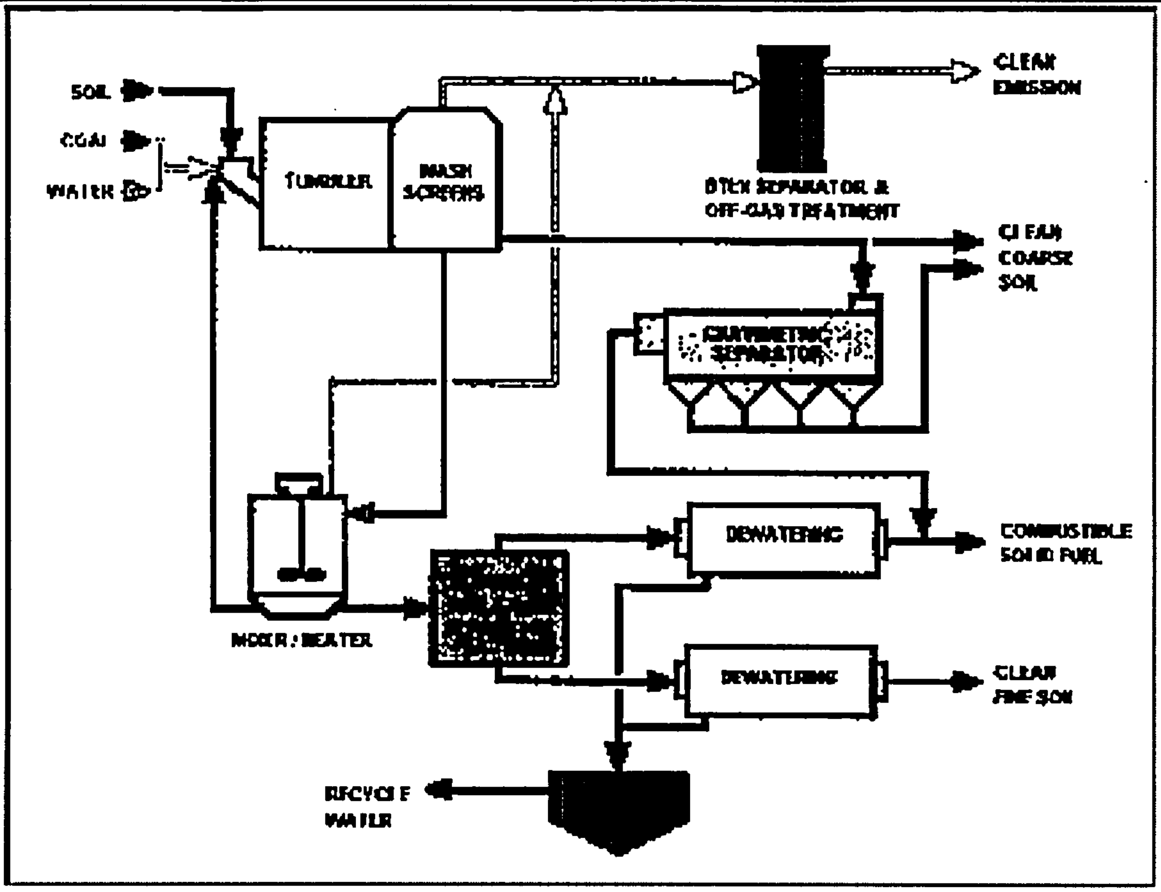
Thermo Design Engineering Ltd., Clean Soil Process

20-Jan-98



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Thermo Design Engineering Ltd., Clean Soil Process

20-Jan-98

Project: Clean Soil Process Demo Plant Commissioning **Year: 95**

Location: Edmonton, Alberta, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone
Thermo Design Engineering	Tony Rojek/Jim Kramer	(403) 440-6064

Not Audited

Feed Rate (Tonne/hr): 10 Amount Treated (Tonne): 120

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: MGP Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal
VOC	750 ppm	0.08 ppm	>99
Tar	8000 ppm	120 ppm	>99
PAH	102 ppm	23.6 ppm	>98
Metals (Total Leachable)	n/a	-	-

Clean-up Goals:

Clean Soil : < 500 ppm Total Soluble Organics; < 50 ppm Total PAH; < 10 ppm Total VOC.
Solid Fuel: Non-Hazardous as per TCLP Analysis for Volatiles/Semi-Volatiles, Metals.

Emissions/ByProducts: Clean Soil: 96 tonnes 75 mm x 0.5 mm
Solid Fuel: 31 tonnes (incl. 7 tonnes coal) 2.4 mm x 0 mm

Description: Clean Soil: Non-hazardous, non-odorous, < 3 % moisture, Landfill Suitable.
Solid Fuel: Non-hazardous, non-odorous, 20-22% moisture, 3000 BTU/lb, suitable for recycling via combustion facility.

Project: Hamilton Harbour **Year: 91**

Location: Hamilton, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Water Technology International Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.02

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Hamilton Harbour sediment. Oil/tar contaminated soil

Contaminants Treated: PAH's; Oil and Grease;

Emissions/ByProducts: Coal with absorbed contaminants.

Description: The study consisted of comprehensive sediment characterization (physical and chemical) followed by treatability tests. This bench scale test represented the first application of the Clean Soil Proces to the very fine solids generally associated with sediments.The treatability testing involved three batch processes - mixing/cleaning with the addition of a variety of conditioning materials, flotation and thermal desorption. Three experimental process trains were tested. The first involved a single conditioning and flotation step, the second, sequential conditioning and flotation steps and the third included thermal desorption of the tailings.

Sample was allowed to settle for two days and the water separated from the solids by decantation.
The contaminated soil is mixed in a rotary drum for 15 minutes at 2,000 rpm at 20 C. This removes the oily/tarry contaminants. Typically coal is added but the Hamilton Harbour soil contained indigenous coal and other hydrophobic species that exhibited profound affinity towards organic compounds.
Carbonaceous materials such as PAH's, and sulfur and nitrogen bearing compounds were then removed by flotaion.
Thermal desorption was then used depending on the residual content of PAH's.
Total PAH's concentration was reduced to below 2 ppm.

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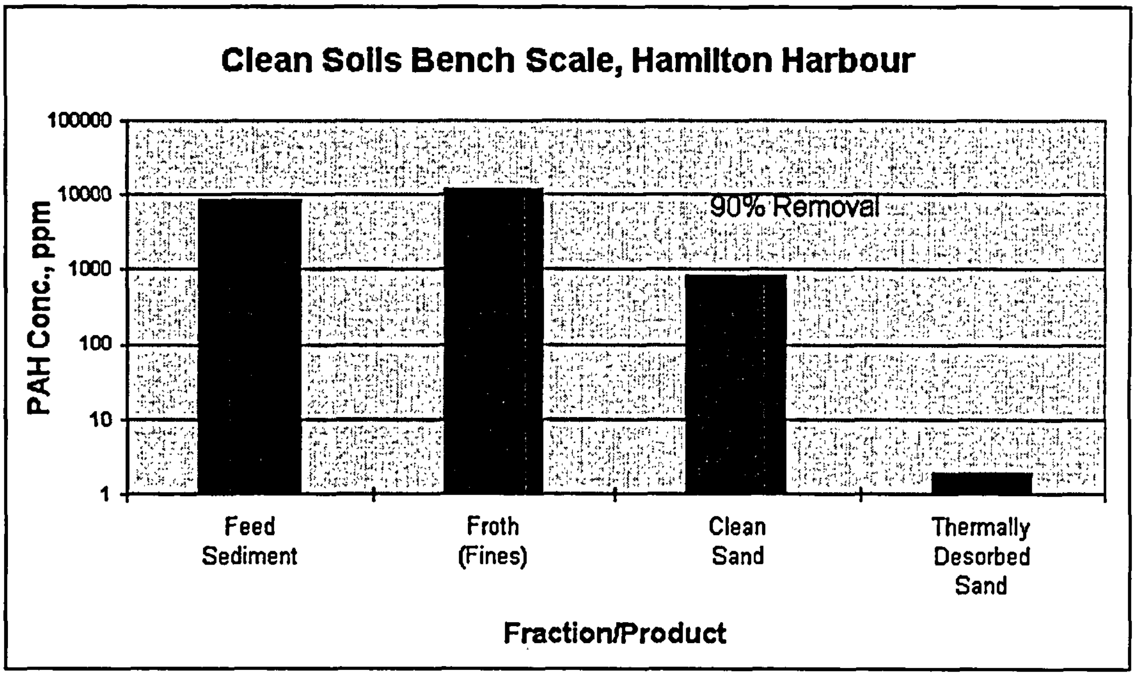

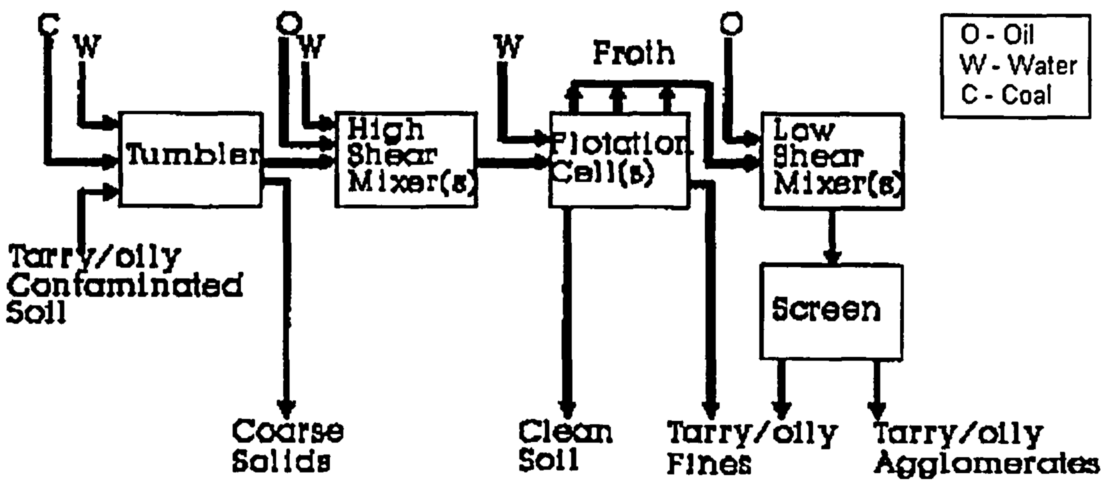

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Toray Filters

20-Jan-98

TechID: 201

Technology Type: Post Treatment, Pre Treatment

Contaminants Treated:

Media Treated: Suspended Sediments

Development Stage: Commercial   **Country Of Origin:** Japan   **Portable:** ☒

Description:

The Toray Filters utilize a unique Torayrom Filter Cloth. The cloth was designed to i) allow the efficient capture of fine (5 micron) particles at high flow rates and ii) simple backwashing.

The filter cloth is composed of two layers made of different material. One layer acts effectively as a support for the second which is a densely woven fine thread (0.6 denier) material. The cloth has been mounted upon the Torayrom RD System and Torayrom TM Press.

The Torayrom RD is a rotating drum filter in which feed enters the inside of the drum and filtrate is allowed to flow outwards. Backwashing is accomplished by a small quantity of spray water applied on the inner and outer surface of the drum. The backwashed solids slurry may be concentrated 50 to 100 times relative to the feed. By passing the backwash from the RD system through the TM Press a 65% filter cake can be produced.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days):   Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): –   Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Filter cake, low solids water

Developers:

Toray International
2-1, Nihonbashi-Muromachi 2-chome
Chuo-ku, Tokyo
Japan 103 -
Notes

Contact:
Phone: (03) 245-5111 Ext:
Fax: 8133245583455
Email:

Literature References:

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Trident Trifirmex Process

20-Jan-98

TechID: 194

Technology Type: Stabilization/Fixation

Contaminants Treated: Heavy Metals

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☒

Description:

The technology consists of mixing a dry powder called Firmex into a semi-fluid mud, controlling the pH, placing it into its permanent depository and allowing it to harden. Comparable to the mixing of concrete the process is time-controlled as increasing the amount of Firmex tends to decrease curing times. Load bearing values from 1000 lb/sq. ft up to 4.5 tons/sq. ft, with fly ash as an additional additive, have been achieved. The leaching of heavy metals has been demonstrated to be reduced, and extremely low permeability coefficients indicate other hazardous waste may be able to be immobilized.

The process being proposed for this technology is only in the design stages and warrants testing.

Limitations: Solids content range 22-60%. Will not handle high organic content solids.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 1 Breakdown Time (days): 1

Feed Rate Average (Tonne/hr): 3

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$30.00 – $70.00** Average Cost (US$/Tonne): **$50.00**

Note: Feed rate is EQUIPMENT DEPENDENT. It usually ranges from 1 - 6 tonnes/hour.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Trident Engineering Associates Inc.
2010 Industrial Drive
Annapolis, MD
USA 21401-
Notes

Contact: Henderson, W.B.
Phone: (410) 224-3550 Ext:
Fax: (410) 224-8630
Email:

Vendors:

Hayward Baker Environmental, Inc.
1130 Annapolis Road
Odenton, MD
USA 21113-
Notes

Contact: Moseley, M.P.
Phone: (410) 551-1995 Ext:
Fax: (410) 551-1994
Email:

Literature References:

Author:
Title:
Journal: Date:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

TriWaste Reduction Services, Thermal Desorption Unit

20-Jan-98

TechID: 315

Technology Type: Thermal

Contaminants Treated: PAH's, Oil & Grease, VOCs, BTEX
Fuels, Non-Chlorinated Solvents, Crude Oil, Lubricating Oil, Oil Field Wastes

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The rotary dryer thermal desorption unit consists of a cylindrical drum inclined slightly from the horizontal. The drum rotates and is fitted with lifters which pick the soil up and drop it through the hot combustion gases. The burner is located at one end and the soil travels counterflow from the other end. As they exit the dryer, the treated soils are sprayed with water for cooling and dust control. The gases flow to a baghouse for particulate removal and then to an afterburner where the gases are combusted at approximately 830°C.

By the end of 1995, we had treated over 40,000 tonnes of soil for 15 clients. Contaminants have included PAH's, fuels, lubricating oil, gas condensate, crude oil, flare pit wastes, and flocculents.

The technology comes in one trailer and sets up in one day.

Limitations: Moisture needs to be less than 30% in the feed. Total petroleum hydrocarbons need to be less than 5% in feed. Chlorinated hydrocarbons, sulphur and Hg are limited in the feed by permit, however this varies by jurisdiction.

Efficiency Description:

Government Funding:

Environmental Concerns: Stack emissions have been tested and meet regulatory limits.

Health & Safety Plan Available: ☒

Regulatory Approvals Alberta License to Operate 93-AL-272. Saskatchewan Permit to Construct and Operate IEW 9414/AQS 687.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $50.00

Assuming 10,000 tonnnes. Contaminant: Petroleum Hydrocarbons. Rate Average: This is an expected throughput.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Site Reclamation Systems Inc.
29511 CR 561, 1
Tuvares, FL
USA 32778-
Notes

Contact: Woods, Larry
Phone: Ext:
Fax:
Email:

Vendors:

TriWaste Reduction Services
1700 - 800 5th Ave. S.W.
Calgary, Alberta
Canada T2P3T6
Notes

Contact: Sherwood, Les
Phone: (403) 234-3240 Ext:
Fax: (403) 261-6737
Email:

TriWaste Reduction Services
1700 - 800 5th Ave. S.W.
Calgary, Alberta
Canada T2P3T6
Notes

Contact: Benoit, Jacques
Phone: (403) 234-3240 Ext:
Fax: (403) 261-6737
Email:

Literature References:

Author: Sherwood, Les
Title: Remediation of Hydrocarbon Contaminated Soils in the Petroleum and Petrochemical Industry Using a Mobile Thermal
Journal: Desorption System
Proceedings: Calgary Environmental Conference and Trade Show Date: Nov 1994

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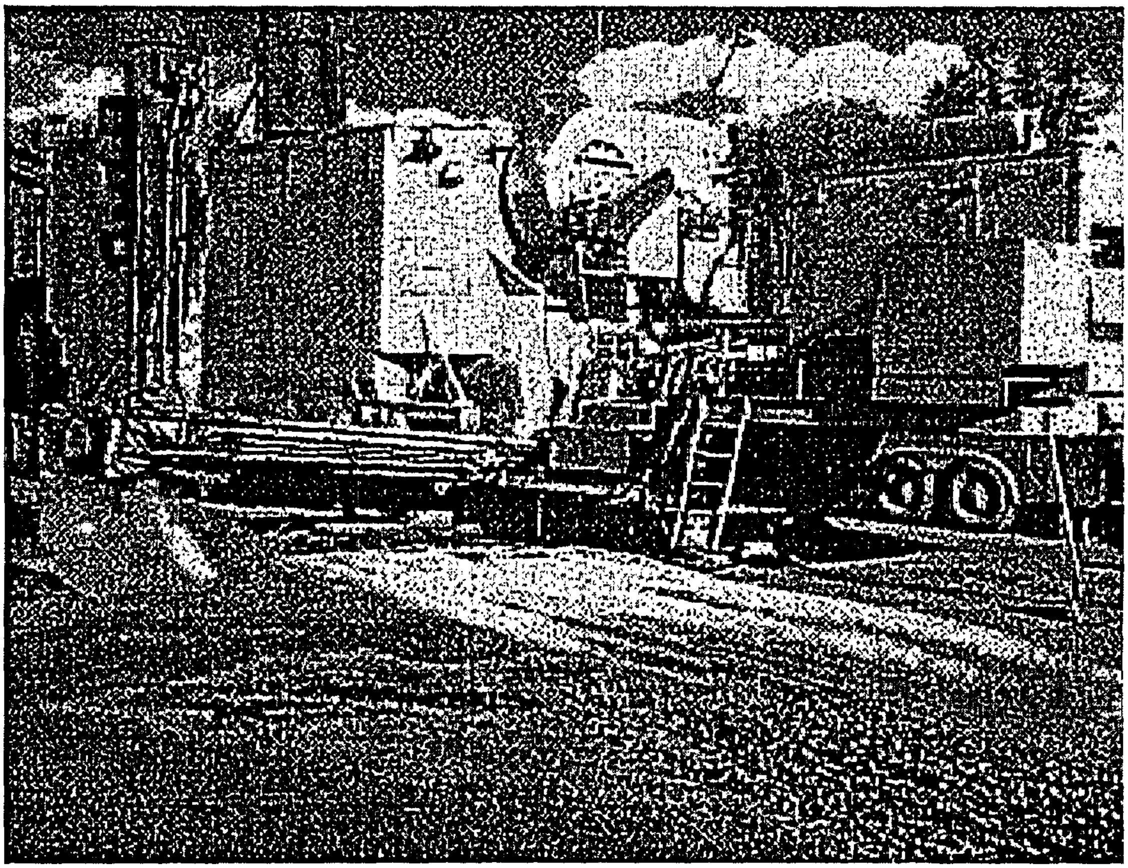
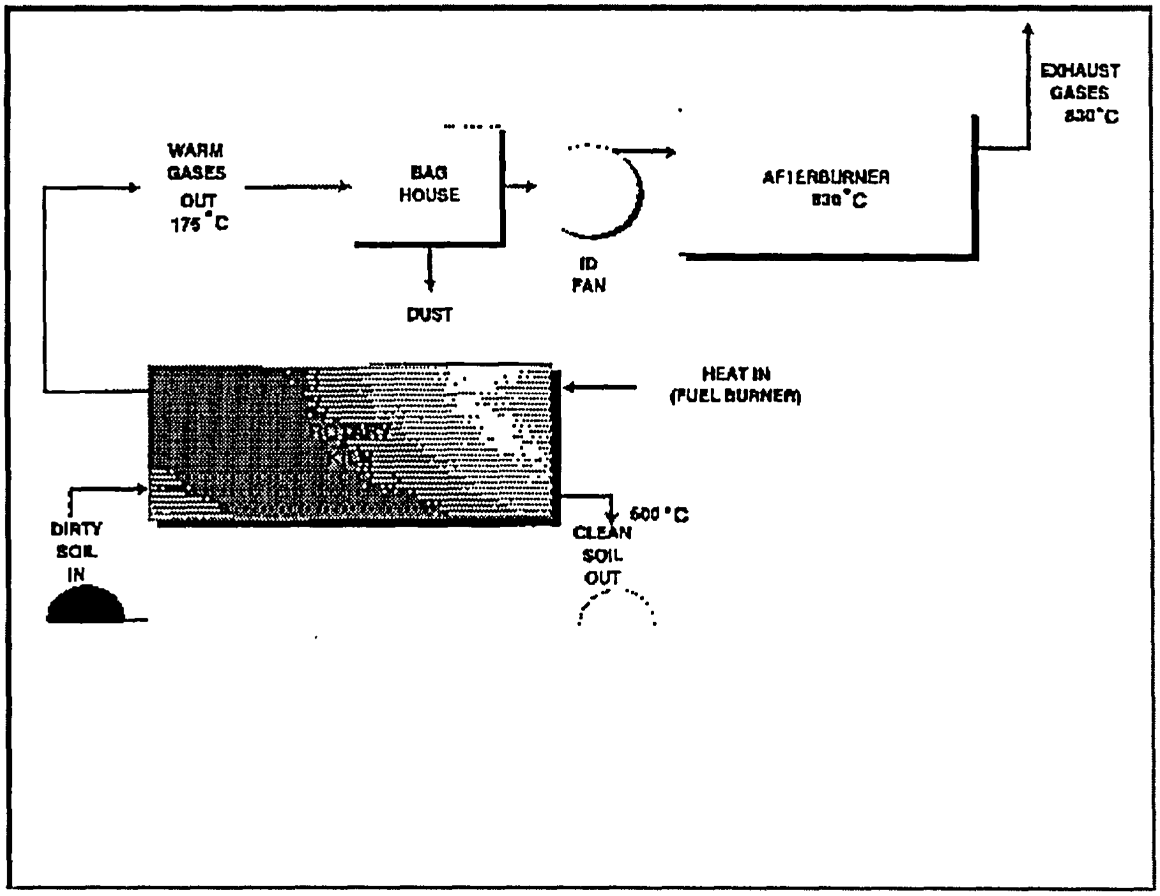
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.





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TriWaste Reduction Services, Thermal Phase Separation Process

20-Jan-98

TechID: 316

Technology Type: Thermal

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, Halogenated Organics, BTEX, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The TriWaste Thermal Phase Separator (TPS) is a mobile indirectly fired thermal desorption system. It uses indirect heating to separate hydrocarbon contaminants from the soil. It can be used to remove chlorinated or non-chlorinated hydrocarbons with boiling points up to 600°C. It is not an incineration proccess and therefore should not produce products of incomplete combustion. It is therefore permitted to treat hazardous wastes including soil contaminated with PCB, pentachlorophemal, herbicides, or other chlorinated compounds.

The Thermal Phase Separator incorporates a two-staged process. The first stage consists of the removal of the organic contaminants by the application of heat in the extraction chamber of the unit. The soil is augured through the extraction chamber by two parallel screw augurs. The extraction chamber is heated externally to up to 650°C, thereby volatilizing the hydrocarbon contaminants. The fuel used can be either propane or natural gas.

The second stage involves cooling the gaseous contaminants and condensing them into liquid form. The cooling is accomplished by quenching followed by a fin-fan cooler. The relatively dry gas stream of non-condensible gases is subjected to final in a mist eliminator and a carbon sludge settling chamber and a three-phase oil/water/solids separator. The hydrocarbon liquids and sludge are drawn off for analysis and disposal or recycling. Water from the oil/water separator is treated through an on-line sand and carbon absorption system and reused for soil rewetting. In some cases excess water may require disposal.

Two sizes of unit are available. The smaller of the two is capable of processing from 3.5 - 7 tonnes of soil per hour. The larger will process 7 - 15 tonnes per hour.

The technology has been used primarily to remediate soils contaminated with PCB, PCP and PAH's. The following removal efficiencies have been found in performance tests.

	Input Data	Output Data	Removal Efficiency
PCB	283.3	1.7	>99.4
Chlorophenols	85.5	0.1	>99.6
PAH's	11857	3.7	>99.5
TEH	11179	59.3	>99.4

Limitations: The smaller of the two units is suitable for projects of greater than 1000 tonnes. The larger is suitable for projects of greater than 5000 tonnes.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns: Stack emissions have been tested and met criteria. Fugitive emissions will need to be controlled on some projects.

Health & Safety Plan Available: ☒

Regulatory Approvals Alberta License to Operate 93-AL-272. Newfoundland AA94-793. British Columbia license pending.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 15

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $300.00

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Particulates; HCl.

Developers:

Ito-Ad Inc.

Company out of business.
Portland, Oregon
USA
Notes

Contact:
Phone: Ext:
Fax:
Email:

Vendors:

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TriWaste Reduction Services, Thermal Phase Separation Process *20-Jan-98*

TriWaste Reduction Services
1700 - 800 5th Ave. S.W.
Calgary, Alberta
Canada T2P3T6
Notes

Contact: Sherwood, Les
Phone: (403) 234-3240 Ext:
Fax: (403) 261-6737
Email:

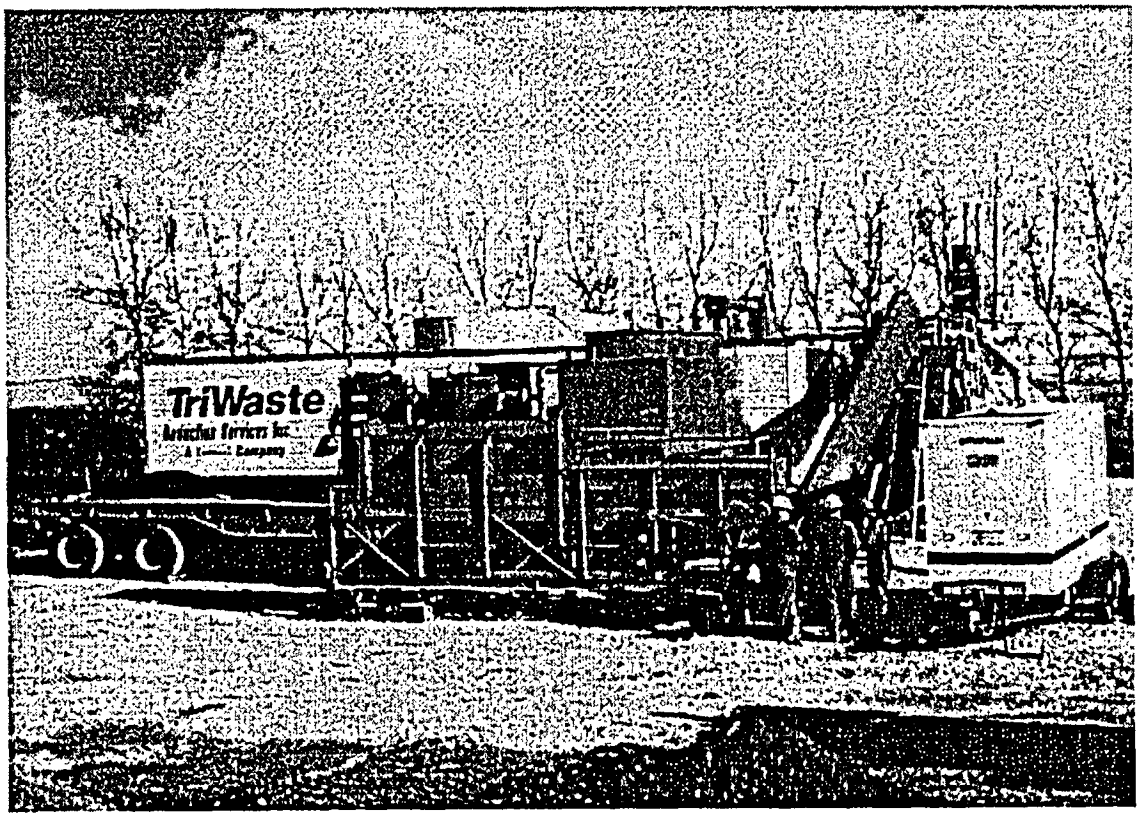
TriWaste Reduction Services
1700 - 800 5th Ave. S.W.
Calgary, Alberta
Canada T2P3T6
Notes

Contact: Benoit, Jacques
Phone: (403) 234-3240 Ext:
Fax: (403) 261-6737
Email:

Literature References:

Author: **Kapila, Mukesh, Rutberg, Bob**
Title: Treatment of PCB Contaminated Soils Using Thermal Desorption
Journal: Proceedings of "Clean-Up of Contaminated Sites in Alberta" Date: **Oct 1994**

Author: **Benoit, Jacques, Kapila, Mukesh**
Title: PCB Contaminated Soil Reduction Using Thermal Desorption
Journal: Proceedings of 17th Annual Waste Management Conference Date: **Sep 1995**



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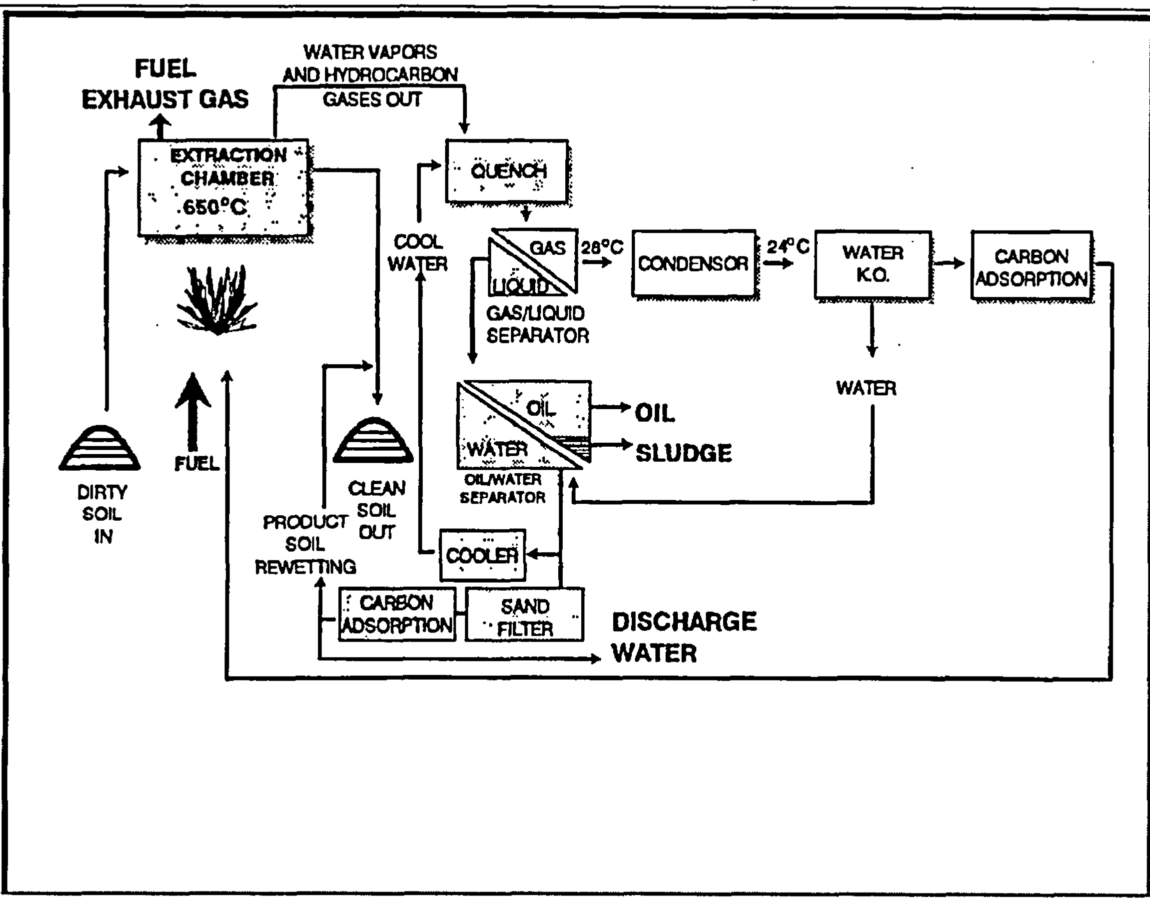

Project: Mackinsons Site **Year:** 95

Location: St. John's, Newfoundland Full Scale Demo

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated:

Contaminants Treated: PCB's

Emissions/ByProducts:

Description: In order to demonstrate that the Model TPS-1 could remediate PCB contaminated soils while maintaining compliance with federal and provincial emission requirements, a series of stack emission tests were performed. The stack gas was monitored for the presence of PCB's, products of incomplete combustion, particulates, and HCl. The emission of dioxins and furans were also measured.

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University of Wisconsin Biological Treatment

20-Jan-98

Technology Type: Biological TechID: 205

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Biological treatment can occur in both aerobic and anaerobic atmospheres. This group proposed to study both in fixed film processes. In-situ and ex-situ treatment will be investigated, along with ways to enhance biodegradation rates.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Vendors:

University of Wisconsin, Seagrant Institute
1800 University Ave.
Madison, WI
USA 53705-
Notes

Contact: Anderson, Mark
Phone: (608) 262-2674 Ext:
Fax: (608) 262-0454
Email: marc@coefac.engr.w

Literature References:

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University of Wisconsin Extraction

20-Jan-98

Technology Type: Metal Extraction, Organic Extraction

TechID: 207

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Work has been performed on the extraction of organics using surfactant/solvents and centrifugation. Centrifugation has been proposed for further investigation.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Vendors:

University of Wisconsin, Seagrant Institute
1800 University Ave.
Madison, WI
USA 53705-
Notes

Contact: Anderson, Mark
Phone: (608) 262-2674 Ext:
Fax: (608) 262-0454
Email: marc@coefac.engr.w

Literature References:

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University of Wisconsin, Advanced Oxidation Process

20-Jan-98

TechID: 206

Technology Type: Chemical

Advanced Oxidation.

Contaminants Treated:

Organics

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Bench Scale **Country Of Origin:** USA **Portable:** ☐

Description:

This technology treats organic contaminants in soils or sediments by coupling an extraction process with an advanced oxidation technology. Extraction processes of interest include near critical water extraction and supercritical fluid extraction using CO2 and modifiers.To date, only near critical water extraction has been tested. While good extraction efficiencies have been obtained, fine material in the test sediment often clogs the frits in the test unit. Advanced oxidation processes of interest include both conventional oxidation and photocatalytic oxidation using proprietary nanoparticulate oxides developed in-house. In several studies to date, these deep oxidation catalysts provide essentially complete mineralization of test organics at lower operating temperatures than corresponding commercial catalysts. Tests of a coupled extraction-oxidation process are expected to begin in the near future.

Limitations: Expected to treat primarily organic contaminants and to operate as a batch process. Extraction process will require operation at elevated pressures.

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.000005

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $500.00 – $750.00 Average Cost (US$/Tonne): $600.00

As this technology is at the Bench-Scale level, cost estimates are very general.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

University of Wisconsin, Water Chemistry Program
660 North Park Street
Madison, WI
USA 53706-
Notes Additional contacts: Armstrong, Andren

Contact: Anderson, Mark
Phone: (608) 262-2674 Ext:
Fax: (608) 262-0454
Email: marc@coefac.engr.w

Vendors:

University of Wisconsin, Seagrant Institute
1800 University Ave.
Madison, WI
USA 53705-
Notes

Contact: Anderson, Mark
Phone: (608) 262-2674 Ext:
Fax: (608) 262-0454
Email: marc@coefac.engr.w

Literature References:

Author: **Fu, X., Zeltner, W.A., Anderson, M.A.**
Title: The Gas Phase Photocatalytic Mineralization of Benzene on Porous TiO2-Based Catalysts
Journal: Applied Catal. B: Environ. 6_[3], 209-224. Date: **Jan 1995**

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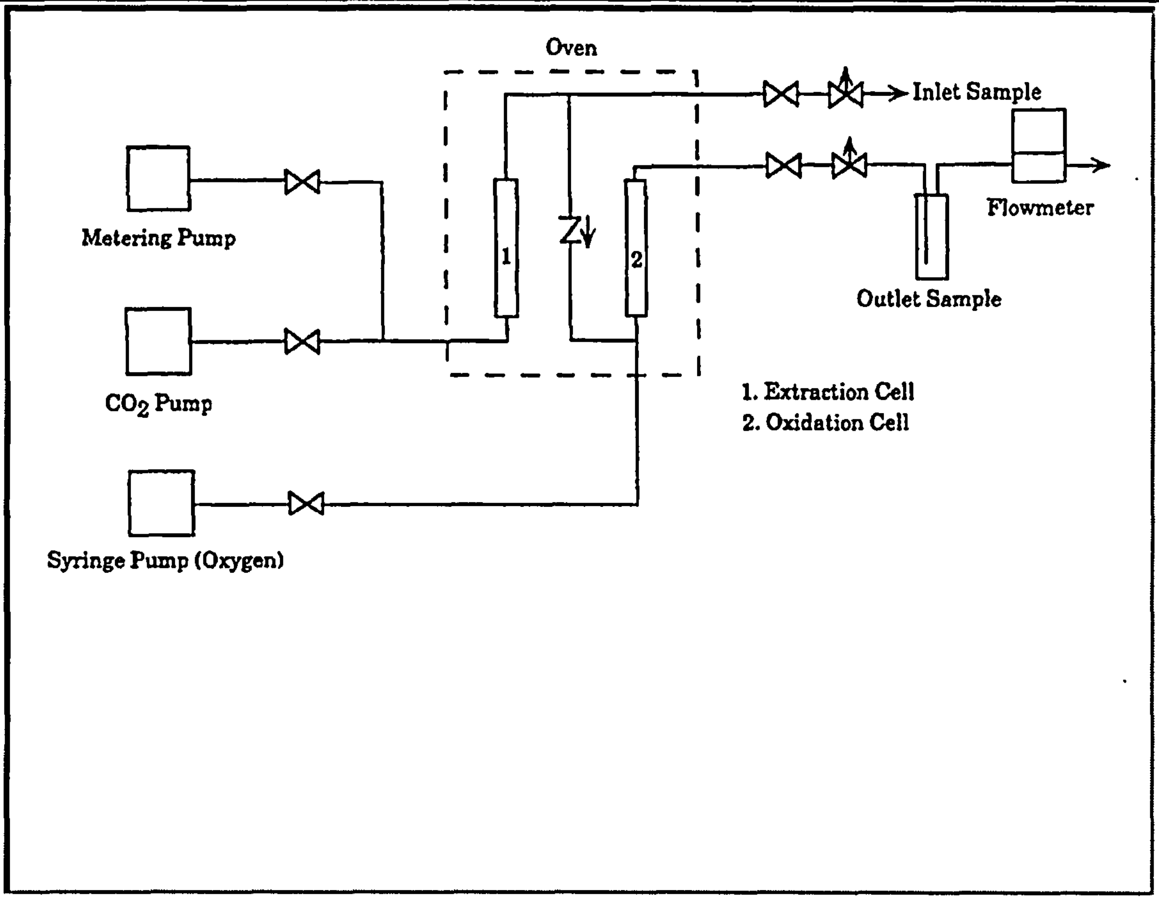
University of Wisconsin, Advanced Oxidation Process

20-Jan-98



Project: Testing of Coupled Extraction - Oxidation Process

Location: University of Wisconsin, WI

Year: 95

Bench Scale

Client/Funding Agency	Contact	Phone
SeaGrant Institute	Anders Andren	(608) 262-0905/2470

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: Standard Sediment

Contaminants Treated: Not available.

Emissions/ByProducts:

Description: Received funding of $250,000 for two years. Amount treated: 2 grams at a time.

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VHBZ Mobile Silt Separation and Treatment Plant

20-Jan-98

TechID: 132

Technology Type: Pre Treatment

Contaminants Treated:

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** The Netherlands **Portable:** ☒

Description:

This technology utilizes screens, hydrocyclones and filters to classify and dewater sediment. The hydrocyclones are adjustable with respect to the separation size. Between most unit processes, computer controlled buffer tanks are situated to provide a homogeneity in the material being processed.

Two vibrating screens are used to remove grossly oversized (> 3cm) and oversized material (> 2mm). Sub-2mm sediment is passed through a group of 6 hydrocylones to obtain a sand/silt separation. The underflow (sand) from this group of hydrocyclones is rinsed to remove any remaining silt particles. The overflow (silt) is directed to a group of 32 hydrocylones which provide a further size classification at 20 to 60 microns. Both silt streams are dewatered by 6 high capacity belt presses, assisted by an automated polymer addition.

Process water streams flow through a clarifier followed by a static polmer filter which removes polar organics and then a coal filter which removes the remaining non-polar contaminants.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Van den Herik Bagger-en Zuigwerken bv.
Industrieweg 24, Postbus 191
Sliedrecht, AD
The Netherlands 3360 -
Notes

Contact:
Phone: 31 18 4012881 Ext:
Fax: 31 18 4019821
Email:

Vendors:

Waterbodem Groep Nederland
Edisonweg 52
Alblasserdam, AD
The Netherlands 2962 -
Notes

Contact: Stam, J.A.
Phone: 31 18 5930200 Ext:
Fax: 31 18 5930196
Email:

Literature References:

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VKI Plasma Waste Destruction Process

20-Jan-98

Technology Type: Thermal

TechID: 152

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs

Media Treated: Sediment Ex-Situ

Development Stage: Pilot Scale **Country Of Origin:** Hungary **Portable:** ☒

Description:

The Plasma Waste Destruction Process utilizes the extreme temperatures (2 000 - 15 000 degrees Celsius) and high energy density of a plasma arc torch to reduce waste to atomic form. Waste is fed to a reactor where vaporization and then decomposition to atoms occurs. The atoms are then cooled under controlled conditions resulting in reaction products which are relatively innocuous (and potentially marketable). The gas exits the reaction chamber at 1200 degrees Celsius and is cooled and scrubbed prior to discharge to the atmosphere.

VKI, the Hungarian Institute for Electricity, promotes the use of the plasma destructor as an ideal technology for the destruction of liquid wastes contaminated by halogenated organics (especially PCBs). The plasma technology tends to have higher destruction efficiency than incinerators, requires only electrical power and has a lower heat inertia then incinerators (enabling quicker mobilization/demobilization).

Pilot tests with PCBs and chlorobenzenes have shown extremely high destruction efficiencies. All state gas emission criteria were easily met.

Limitations:

Efficiency Description: Greater than 10 9's destruction of PCBs has been achieved at pilot scale.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr): 0.002

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Clean cooling water, scrubber sludge, off-gases (see technology description)

Developers:

Villamosipari Kutato Intezet
Cservenka Miklos u. 86
Budapest,
Hungary 1158 -

Contact: Bencze, L.
Phone: 36-1-252-5222 Ext:
Fax: 36-1-183-0323
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Vortec Corporation, Oxidation/ Vitrification Process

20-Jan-98

TechID: 213

Technology Type: Vitrification

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, Halogenated Organics, Explosives, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

The Vortec oxidation/vitrification process converts organic and heavy metal contaminated solid wastes into chemically stable glass and ceramic products. The glass and ceramic products manufactured from contaminated soils, sludges, and industrial wastes can be sold as value-added products. The process uses fossil fuels or organic containing wastes as the energy source, thereby substantially reducing energy costs. Waste heat from the process is used to dry wet soils or sludges, resulting in a very energy efficient process for converting soils and dredging sludges into value-added glass and ceramic products. The process can receive and process drummed waste as well as bulk wastes. Wastes contaminated with organics (including PCB's), as well as RCRA heavy metals, can be utilized. The glass/ceramic products can be used as backfill or building and road construction applications.

Limitations: Not suitable for contaminated water, slurries. Sludges should have water content less than 60%.

Efficiency Description: 99.9999 %

Government Funding: SITE

Environmental Concerns: Stack emissions

Health & Safety Plan Available: ☒

Regulatory Approvals Pennsylvania, Ohio, Kentucky

Setup/Feed: Setup Time (days): 30 Breakdown Time (days): 15

Feed Rate Average (Tonne/hr): 10

Cost: Capital Cost (US$): $15,000,000

Treatment Cost (US$/Tonne): $40.00 – $80.00 Average Cost (US$/Tonne): $60.00

Process is barge mounted. Location for processing is accessable by barge. The glass products manufactured can be sold for $10 to $40/ton. The processing cost excludes any credits or revenues from the sale of the glass products.

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: CO2, H2O, trace quantities of acid gases.

Developers:

Vortec Corporation
3770 Ridge Pike
Collegeville, PA
USA 19426-3158
Notes

Contact: Hnat, James
Phone: (610) 489-2255 Ext:
Fax: (610) 489-3185
Email:

Vendors:

Vortec Remediation Services
3770 Ridge Pike
Collegeville, PA
USA 19426-
Notes

Contact: Eglinton, Yvonne
Phone: (610) 489-2255 Ext:
Fax: (610) 489-3185
Email:

Mitsubishi Kasei Engineering
2-12, Sendagaya 4-chome, Shibaya-Ku
Tokyo,
Japan 151 -
Notes

Contact: Iwasa,
Phone: Ext:
Fax:
Email:

Literature References:

Author: **Hnat, J., Patten, J., Jian, C.**
Title: Vitrification of Waste Streams Containing RCRA Metal Compounds
Journal: EPA Workshop on Arsenic and Mercury: Removal, Recovery, Treatment, and Disposal Date: Aug 1992

Author: **Hnat, J., Bartone, L.**
Title: Recycling of Incinerator Ash into Value Added Glass Products

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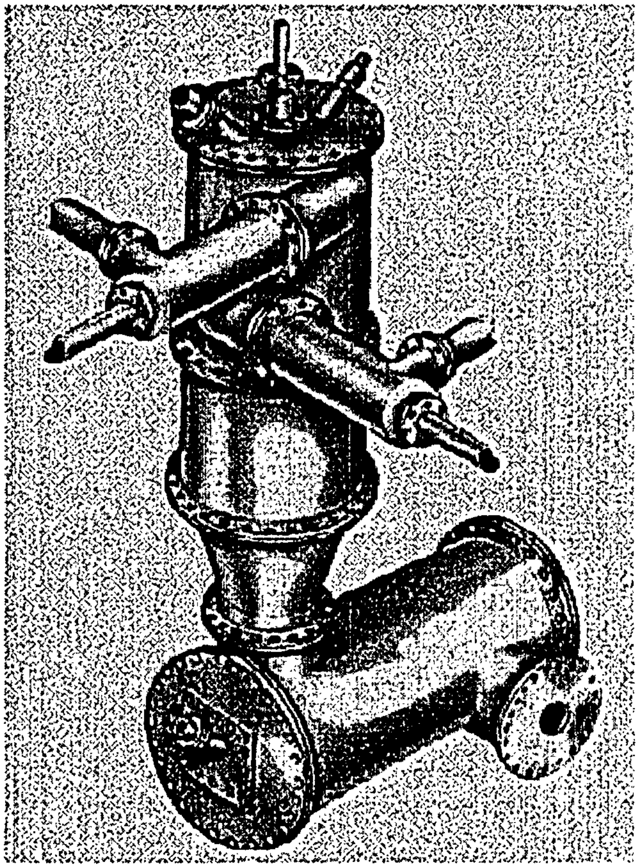
Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Journal: Glass Production Technology International — Date: Jan 1993

Author: **Jetta, N., Patten, J., Hnat, J.**
Title: Innovative Vitrification for Soil Remediation
Journal: Waste Management Conference (Tucson, AZ) — Date: **Feb 1996**



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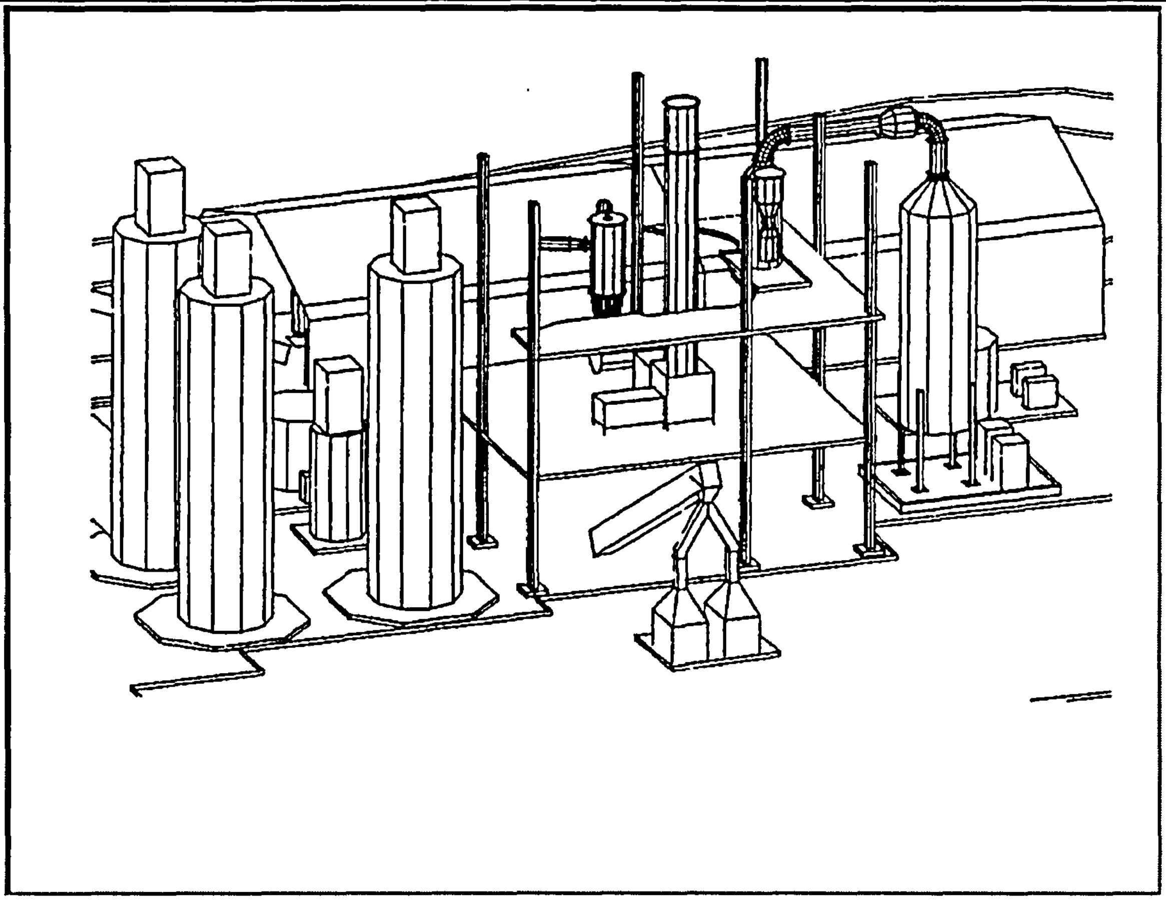
Vortec Corporation, Oxidation/ Vitrification Process

20-Jan-98



Project: Spent Pot Lining Recycling **Year: 95**

Location: , Ohio, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Ormet Aluminum	John Reggi	

Not Audited

Feed Rate (Tonne/hr): 2

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 180

Breakdown Time (days):

Media Treated: KO88

Contaminants Treated:

	Untreated:	Treated:
Cyanides	0-32,000 ug/g	ND
Fluoride	130,000 ug/g	5,000 - 10,000 ug/g

Cleanup Goals: Essentially 100% destruction of cyanides and immobilization of fluoride in glass structure.

Emissions/ByProducts: Glass products sold to glass and ceramic industries.

Description: The Vortec oxidation/vitrification process is used to recycle spent pot liners (KO88) from aluminum smelting operations into value-added glass and ceramic products. The waste contains 25 % contaminated carbon wastes with cyanide contamination. The process uses the carbon cathode as well as insulation bricks for the manufacture of value-added products. Amount treated per year: 13,600 tonnes. Operation is client owned and operated (i.e. permanent installation).

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Waste Stream, Bioremediation *20-Jan-98*

Technology Type: Biological TechID: 216

Contaminants Treated: PAH's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, VOCs, BTEX, Explosives Sulphides, Coal tar, Oil tar

Media Treated: Sediment Ex-Situ, Soil Ex-Situ

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

On site bioremediation of difficult contaminants other than petroleum hydrocarbons.

The team of Waste Stream and Eimco bring together a highly experienced group of individuals in waste treatment technology. Both companies have demonstrated considerable expertise in the full scale development and implementation of large waste treatment systems. Eimco is one of the largest manufacturers of wastewater treatment plant equipment in the world, and Waste Stream is one of the leading US Bioremediation technology companies. Eimco currently has for sale Biolift Reactors for pilot scale projects and full scale projects (over 500,000 gallon reactors) for future application.

The technology approach has been under study and development by both of the companies for over 5 years, and both companies have been involved in large projects which have been overseen by independent parties to verify applicability abd performance.

Limitations:

Efficiency Description: Up to 95% destruction organics.

Government Funding: Great Lakes Cleanup Fund, ETP

Environmental Concerns:

Health & Safety Plan Available: ☒

Regulatory Approvals Ontario MOE Certificate of Approval at Port Stanley Oil Tar Site.

Setup/Feed: Setup Time (days): **15** Breakdown Time (days): **15**

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$20.00 – $80.00** Average Cost (US$/Tonne): **$35.00**

Assuming 10,000 tonnes; hydrocarbon/oil tar contaminant

Database References: ATTIC ☒ VISITT ☒

Emissions / By-Products: Some air emissions possible, but can be controlled.

Developers:

Waste Stream Technology Inc.
302 Grote St.
Buffalo, NY
USA 14207-2496
Notes

Contact: Barnhart, Mike
Phone: (716) 876-5290 Ext:
Fax: (716) 876-2412
Email:

Literature References:

Author: **Stearns & Conrad Engineers**
Title: Technical Summary Report for the Pacific Place Project Special Waste Treatability Study Program
Journal:
Date:

Author: **Waste Stream Technology Inc.**
Title: Treatability Study for Bioremediation of Contaminated Soils at the Pacific Place Site in Vancouver, British Columbia,
Journal: Canada
Date:

Author: **Waste Stream Technology**
Title: Bench-Scale Treatability Study of the Slurry Phase-Bioremediation of Hamilton Harbour Sediments
Journal: Prepared for Great Lakes Cleanup Fund
Date: **Jan 1993**

Author: **Stearns & Conrad Engineers**
Title: Bioremediation Project, Pacific Place Site
Journal: DESRT Technical Summary Sheet #09E
Date: **Apr 1993**

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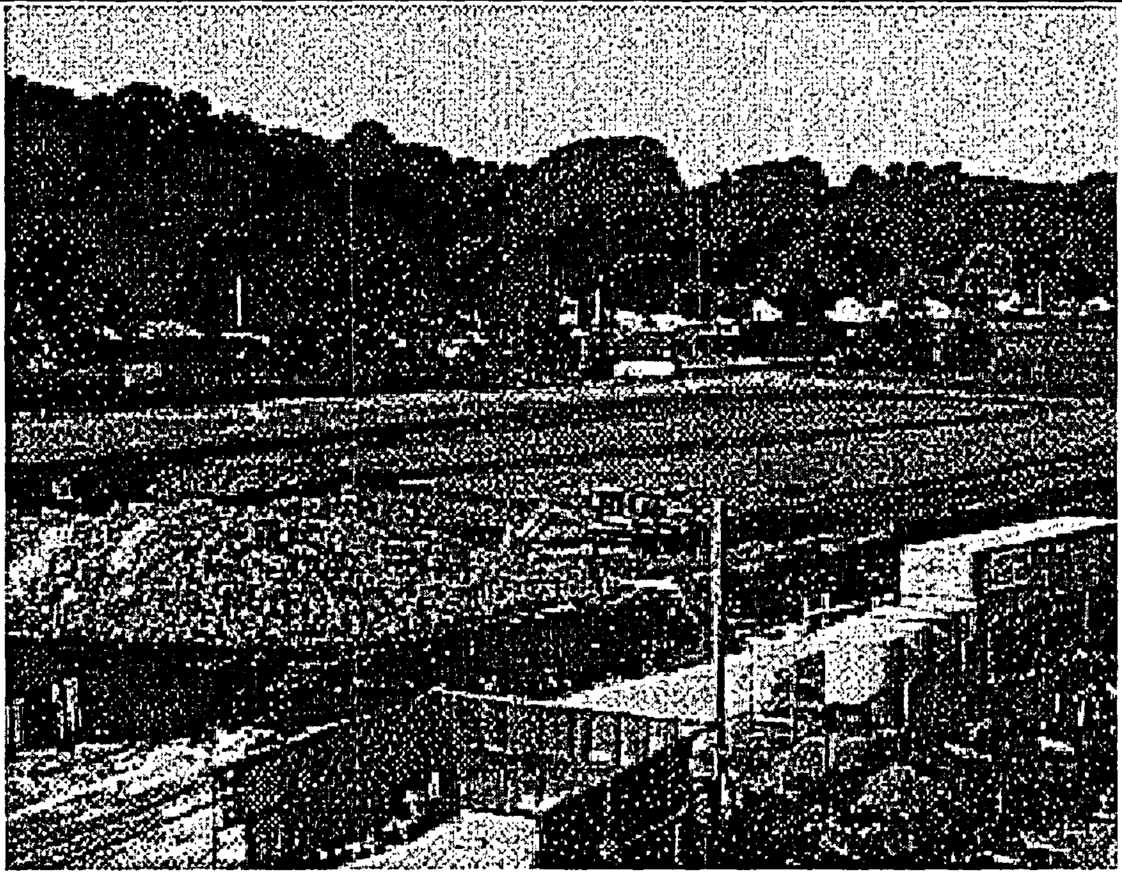

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Project: Pacific Place Site — **Year: 93**

Location: Vancouver, British Columbia, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Soil

Contaminants Treated:

Contaminants	Untreated:	Treated:
Total PAH's (Sample 1)	2053 mg/kg	683 mg/kg
Total Chlorophenols (Sample 1)		
TEH (Sample 1)	9675 mg/kg	5630 mg/kg

Cleanup Goals: British Columbia Standards for Managing Contamination from the Pacific Place Site.

Emissions/ByProducts:

Description: Studies conducted over an 18 to 35 week period. Biostimulated, sterile control, and several bioaugmented soil pan reactors were established for each soil type. Soils were monitored and sampled throughout the study for physical and chemical characteristics and microbial enumeration. Head space studies in flasks were also performed to evaluate any losses of organic contaminants due to volatilization.

Project: Hamilton Harbour Sediments — **Year: 92**

Location: Hamilton, Ontario, Canada — Bench Scale

Client/Funding Agency	Contact	Phone
Great Lakes Cleanup Fund	John Shaw	(905) 336-6273

*** Audited *** Auditing Agency: Craig Wardlaw, Wastewater Technology Centre Phone: (905) 336-4691

Feed Rate (Tonne/hr): Amount Treated (Tonne): 0.05

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sediment. Sediments were prescreened in a 30 mesh sieve and added to dechlorinated tap water to a concentration of 30% (w/v).

Contaminants Treated:

	Initial (ppm)	After 28 days (ppm)
Total PAHs	1800	630

Therefore a 65% removal of total PAH was achieved after 28 days.

Emissions/ByProducts:

Description: Treatability study to determine if the PAHs in the Hamilton Harbour sediments can be remediated in a slurry phase reactor. The success is dependent on the ability of bacteria to degrade PAHs in an aqueous environment and the effect of the myriad of metals on the bioremediation process.

All studies were performed in a 60 litre slurry reactor. The slurry reactor was provided with a consant supply of air. Sediments were mixed continuously by an impeller and by a rotating air lift that moved sediments vertically through the apparatus.
Sediments were segregated into 3 individual microcosms consisting of 18.2 kg each. The microcoms consisted of
1. Untreated control. To determine non-biological contaminant losses.
2. Biostimulation. Microcosm amended with WST Nutriblends. This solution is designed to promote bacterial growth and replication. It contains nitrogen, phosphorous and trace minerals at the appropriate oxidative state.
3. Bioaugmentation. A specific contaminant-degrading bacterium, WST Bioblend M-3MCA, was added concomitant with WST Nutriblends. This organism was chosen based on historical data as well as a pre-screen treatability test. Bacteria were grown in mineral media and carbon for 18 hours. A 1% (v/v) inoculum was used for inoculation into the reactor.

DISCUSSION:
The results of this study indicate that slurry-phase treatment with WST Bioblend M-3MCA resulted in a significant degradation of PAHs. The metals in the soil did not appear to interfere substantially with the remediation process. Bio remediation of the PAH contaminated sediment was dependent on bioaugmenatation with the Waste Stream Bioblends, as there was no significant degradation in either the distilled water microcosm or the biostimulate microcosm.
The rate of degradation was maximum during the first 14 days of treatment and became asymptotic thereafter. Although slurry reactors allow less treatment of material when compared with ex situ solid phase, the loss of material handling is made up in the quick treatment turn around.

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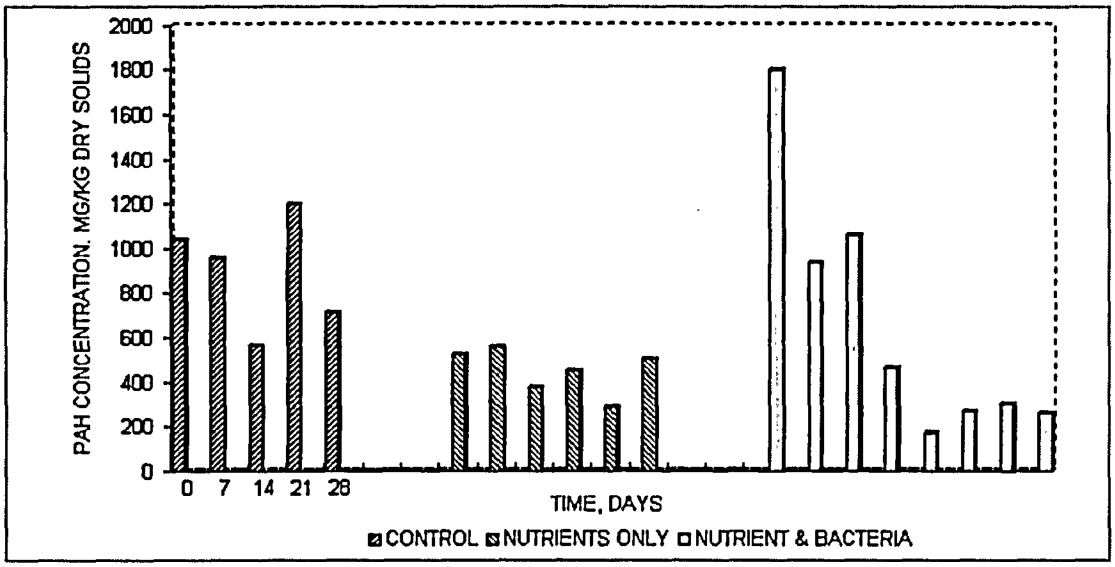

Project: Clark's Gulf Gasoline Station **Year: 90**

Location: W. Springfield, Massachusetts, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Environmental Manager	Don Beck	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: In-Situ Soil

Contaminants Treated: Contaminants

BTEX

Emissions/ByProducts:

Description:

Project: Port Stanley Oil Tar Site **Year: 88**

Location: Port Stanley, Ontario, Canada — Full Scale Demo

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days): 15 Breakdown Time (days): 15

Media Treated: Soil

Contaminants Treated:

	Untreated:	Treated:	% Removal	Untr. Leachate	Tr. Leachate
PAH's	10,000 ppm	50-200 ppm	95	20-60 mg/l	<0.001

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Waste Stream, Bioremediation

20-Jan-98

Cleanup Goals: < 100 ppm total PAH; < 10 ppm Benzo@pyrene

Emissions/ByProducts: Some slight air emissions.

Description: Ex-Situ bioremediation utilizing specially prepared bacteria. Amount 100,000 m^3+. Treatment cost: $43.00/ton

Project: Niagara Falls Air Force Base

Year:

Location: Niagara Falls, New York, USA

Full Scale Demo

Client/Funding Agency	Contact	Phone
Contracting Officer	Dennis Pasiak	

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne):

Treatment Cost (US$):

Setup Time (days):

Breakdown Time (days):

Media Treated: In-Situ Soil

Contaminants Treated: Contaminants	Untreated:	Treated:
TPH		25 ug/g

Emissions/ByProducts:

Description:

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Wastech Molecular Alteration/Stabilization

20-Jan-98

TechID: 214

Technology Type: Stabilization/Fixation

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Soil In-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

WASTECH applies a chemical treatment to the contaminants. The chemical treatment molecularly alters the contaminants to produce a non-hazardous material and then stabilization technology is used to adsorb and encapsulate all treated materials.

Limitations:

Efficiency Description: Leachability meets requirements of EPA and NRC, treated material exhibits significant contaminant reduction following Total Waste Analysis.

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Meets leachability requirements of US EPA and US NRC

Setup/Feed: Setup Time (days): **10** Breakdown Time (days):

Feed Rate Average (Tonne/hr): **3**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): **$150.00 – $450.00** Average Cost (US$/Tonne): **$300.00**

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Solid mass and negligible emissions

Developers:

WASTECH, Inc.
114 Tulsa Rd., P.O.Box 4638
Oak Ridge, TN
USA 37831-

Contact: Peacock, K.
Phone: (615) 483-6515 Ext:
Fax: (615) 483-4239
Email:

Notes

Literature References:

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Environment Canada does not guarantee the accuracy of the information in the database, although every effort was made to provide factual and truthful information.

Wastewater Technology Centre, Generic Solidification Formulation Development

20-Jan-98

Technology Type: Stabilization/Fixation, Pre Treatment

TechID: 364

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Heavy Metals, Radionuclides, Mercury, VOCs, Dioxins/Furans

Limited treatment of BTEX and Halogenated Organics. Treatment of Oil and Grease at < 10%.

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☒

Description:

Solidification is a process wherein the waste is mixed with cementitious and/or pozzolanic material to form either a monolithic or granular product. Our formulations are developed to form a monolithic specimen to maximize the physical benefits of a dense impermeable matrix. Chemical containment is effected through pH control and/or through pretreatment to respeciate contaminants to less soluble species. After mixing, placement can be made using standard cement industry methods (pump, truck, etc.).

Limitations: Treatment does not remove or destroy contaminants, but contains them within matrix.

Efficiency Description:

Government Funding: DESRT

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): 3 Breakdown Time (days): 2

Feed Rate Average (Tonne/hr): 7

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): $50.00

Assuming 10,000 tonnes.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
Canada L7R4L7

Contact: Stegemann, Julia
Phone: (905) 336-4738 Ext:
Fax: (905) 336-8912
Email:

Notes

Vendors:

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
Canada L7R4L7

Contact: Stegemann, Julia
Phone: (905) 336-4738 Ext:
Fax: (905) 336-8912
Email:

Notes

Literature References:

Author: **Sawell, et al**
Title: Evaluation of Solidified Fly-Ash from a Modular Municipal Waste Incinerator
Journal: Journal of Hazardous Materials Date: **Jan 1990**

Author: **Caldwell, R.J., et al**
Title: Treatability of Organic Contaminants by Sorbent Assisted Solidification
Journal: Canadian Portland Cement Association Symposium of Cement Industry Solutions to Waste Management Date: **Oct 1992**

Author: **Stegemann, J.A., Caldwell, R.J., Shi, C.**
Title: Field Evaluation of Test Methods for Solidified Waste Evaluation: A Status Report
Journal: Stabilization and Solidification of Hazardous Radioactive and Mixed Wastes, ASTM STP 1240 Date: **Nov 1993**

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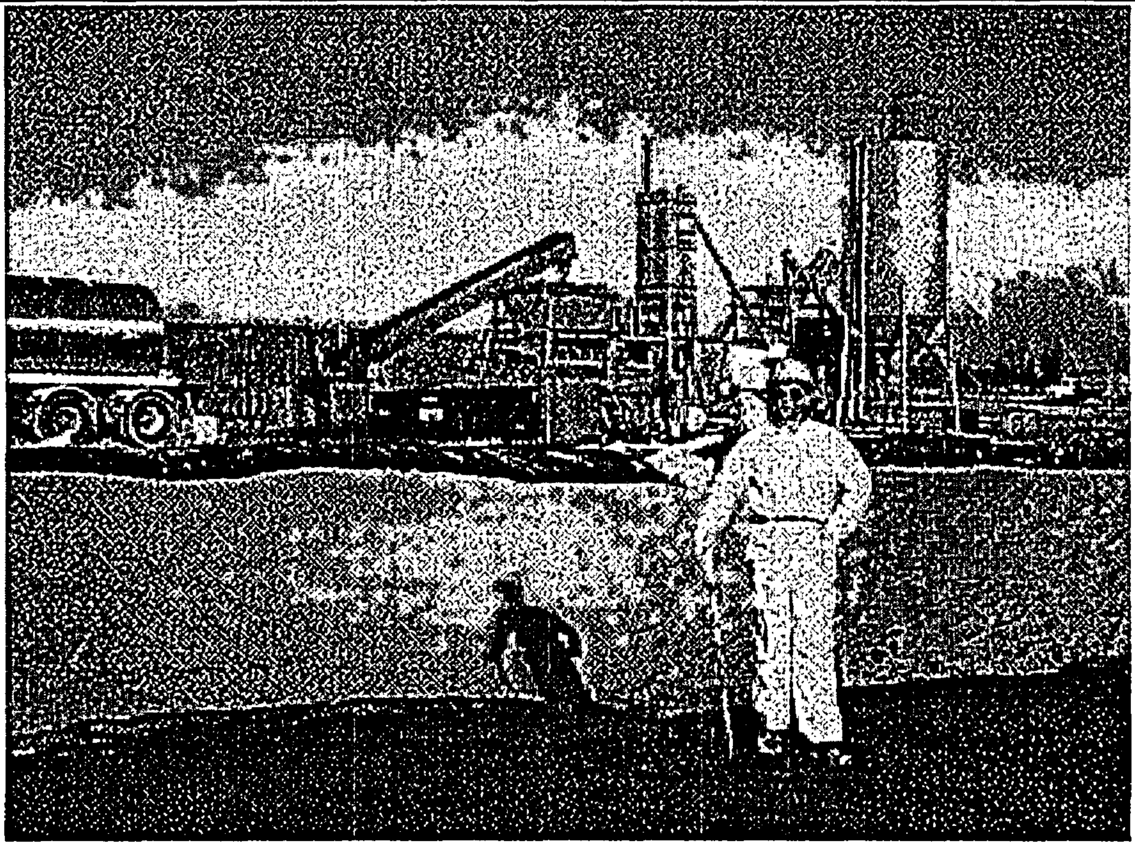
Wastewater Technology Centre, Generic Solidification Formulation Development

20-Jan-98



Project: Field Validation of Test Methods **Year: 93**

Location: Sarnia, Ontario, Canada

Full Scale Demo

Client/Funding Agency	Contact	Phone
DESRT	Lisa Keller	(819) 953-0962

Not Audited

Feed Rate (Tonne/hr): 1 Amount Treated (Tonne): 63

Treatment Cost (US$):

Setup Time (days): 3 Breakdown Time (days): 2

Media Treated: Electric Arc Furnace Dust

Contaminants Treated:

Contaminant	Untreated:	Treated:	% Removal	Untr. Leach.	Tr. Leach.	Test Me.
Cadmium	110	40	Dilution	3.4	0.0065	Reg. 347
Chromium	47000	24700	"	1.8	0.024	Reg. 347
Mercury	13	5.08	"	0.012	0.00054	"
Lead	8700	4496	"	1.4	< 0.04	"

Emissions/ByProducts:

Description: A blastfurnace slag-based formulation was used in a demonstration-scale landfill. Extensive laboratory and quality control testing was performed, including the WTC Solidified Waste Evaluation Protocol.
Cost: Approx. $52.00/tonne treated (reagent cost).

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Wastewater Technology Centre, Self-Sealing/Self-Healing Waste Containment System

20-Jan-98

TechID: 366

Technology Type:

Capping; Liner

Contaminants Treated: Heavy Metals

Sulphides; Acid Mine Drainage

Media Treated: Sediment In-Situ, Soil In-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** Canada **Portable:** ☐

Description:

The Self-Sealing/Self-Healing (SS/SH) barrier concept offers unique economic and technical advantages over existing technologies, and has the potential to satisfy the criteria for a successful landfill barrier system. The SS/SH barrier functions on the principle that two reactive parent materials, when placed in layers, will react at the interface to form an insoluble, highly impermeable seal. The primary advantage of this system, over conventional liners, is that unlike conventional barriers (which in the event of a breach in the liner it may be difficult to discover and if found, repair may entail an expensive excavation), any disruption of the impermeable layer of the SS/SH barrier will lead to new contact of the parents, and renewed formation of the seal.

Average application and installation costs: $20, 000 US/ha.

Limitations: A containment system, some contaminants may also be treated by adsorption/coprecipation reactions.

Efficiency Description:

Government Funding: DESRT, ETP

Environmental Concerns: Requires long-term monitoring.

Health & Safety Plan Available: ☐

Regulatory Approvals None currently.

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): $0.00 – Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products:

Developers:

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
Canada L7R4L7
Notes

Contact: Stegemann, Julia
Phone: (905) 336-4738 Ext:
Fax: (905) 336-8912
Email:

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
Canada L7R4L7
Notes

Contact: McGregor, Rick
Phone: (905) 336-6479 Ext:
Fax: (905) 336-4765
Email: richard.Mcgregor@c

Vendors:

Netherlands Energy Research Foundation
Westerduinweg 3, P.O.B. 1
Petten,
The Netherlands NL 17552G
Notes

Contact: Van der Sloot, Hans
Phone: 31224564249 Ext:
Fax: 31224563488
Email: vandersloot@ecn.nl

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
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Notes

Contact: Stegemann, Julia
Phone: (905) 336-4738 Ext:
Fax: (905) 336-8912
Email:

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Wastewater Technology Centre, Self-Sealing/Self-Healing Waste Containment System

20-Jan-98

Wastewater Technology Centre
867 Lakeshore Rd.
Burlington, ON
Canada L7R4L7

Contact: McGregor, Rick
Phone: (905) 336-6479 Ext:
Fax: (905) 336-4765
Email: richard.Mcgregor@c

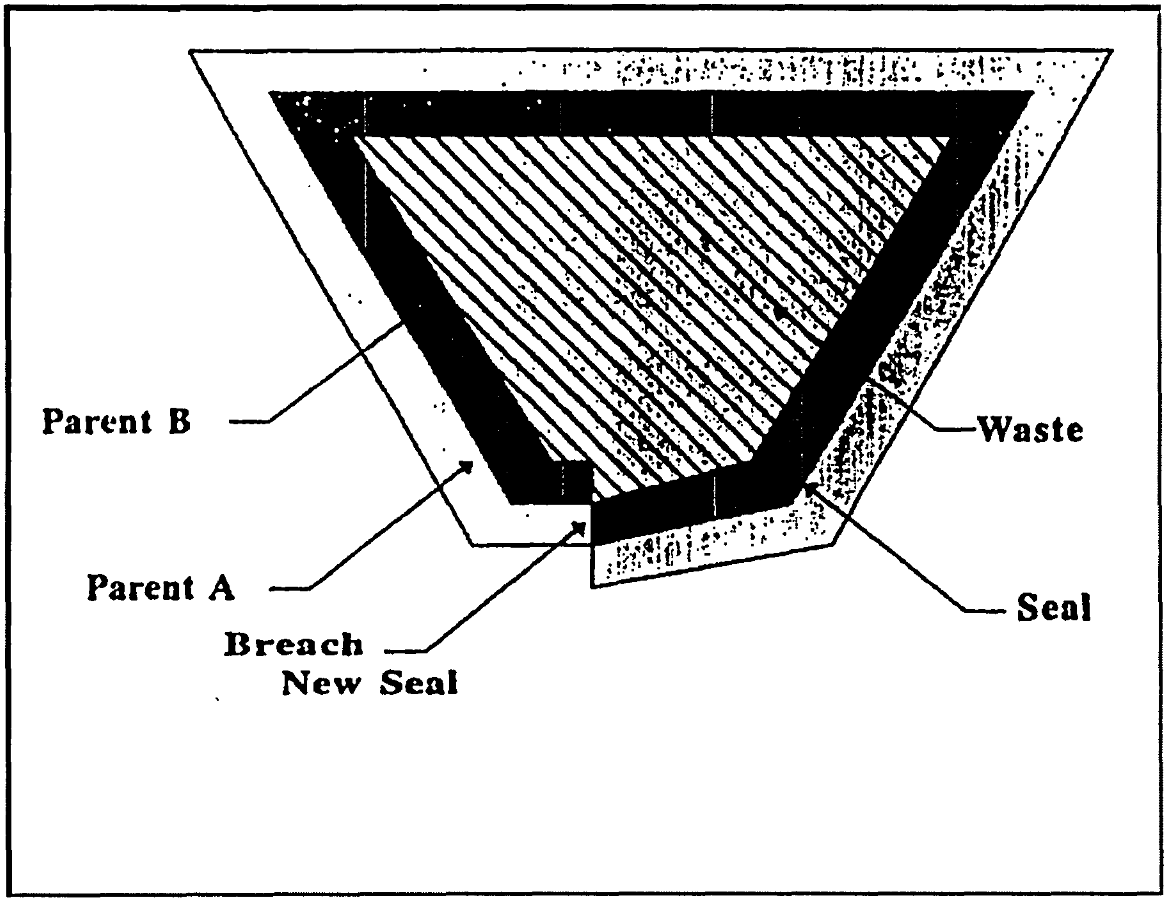
Notes

Literature References:

Author: **Van der Sloot, H., Pereboom, D., McGregor, R., Stegemann, J., Taat, J.**
Title:
Journal: Proceedings, 5th International Landfill Symposium
Date:

Author: **Beck, W., Stegemann, J.A., McGregor, R., Van der Sloot, H.**
Title: Development of a Self-Sealing/Self-Healing Barrier to Resist the Movement of Groundwater and Leachate
Journal: Proceedings, 4th Annual Symposium on Groundwater and Soil Remediation
Date: **Sep 1994**

Author: **McGregor, R.G., Beck, W., Stegemann, J.A., Van der Sloot, H.**
Title: A Self-Sealing/Self-Healing Waste Containment System
Journal: Proceedings, 5th Annual Symposium on Groundwater and Soil Remediation, Toronto, Ontario, Canada
Date: **Oct 1995**



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Wastewater Technology Centre, Self-Sealing/Self-Healing Waste Containment System *20-Jan-98*

Project: Sulphide Mine Tailings **Year: 95**

Location: Sudbury, Ontario, Canada

Client/Funding Agency	Contact	Phone

Not Audited

Feed Rate (Tonne/hr):

Amount Treated (Tonne): 8000000

Treatment Cost (US$): $500.00

Setup Time (days):

Breakdown Time (days):

Media Treated: Mine Tailings

Contaminants Treated: Sulphide

Emissions/ByProducts: N/A

Description: Porosity Reduction: Untreated : 50%. Treated : 25%. Hydraulic Conductivity: Untreated : 10(-5) cm/s. Treated : 10(-11) cm/s. Amount treated (area) : 100 m². Treated cost (per unit area): $50,000/ha.
Project was done to provide a barrier to O2 and water infiltration into tailings to prevent/reduce the rate of sulphide oxidation.

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WBB Hydro SILT-PAC

20-Jan-98

Technology Type: Pre Treatment TechID: 180

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** England **Portable:** ☒

Description:

The SILT-PAC was developed for the clarification of quarry effluent in the mining industry. The system usually consists of a dynamic separator (SILT-PAC Concentrator) followed by the SILT-PAC Cone Thickener. To assist the separation, polymers are added prior to entry of the waste into the Concentrator. A 50% to 60% solids sludge is typically obtained.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Thickened sludge (up to 50% solids wt/wt), <50 ppm "clean" water

Developers:

WBB Hydro Limited
30 Highweek Road
Newton, Abbot, Devon
United Kingdom TQ12 1TP
Notes

Contact: Archer, R.
Phone: 44 626 332349 Ext:
Fax: 44 626 335224
Email:

Vendors:

HIL Technology Inc.
94 Hutchins Drive
Portland, Maine
USA 04102-
Notes

Contact: Knight, Audrey
Phone: (207) 756-6200 Ext:
Fax: (207) 756-6212
Email:

Literature References:

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Weston Low Temperature Thermal Treatment (LT3) System

20-Jan-98

Technology Type: Thermal

TechID: 119

Contaminants Treated: VOCs

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Full Scale Demo **Country Of Origin:** USA **Portable:** ☒

Description:

Soil waste is heated to sub-combustion temperatures (approximately 340 °C) to dry and volatilize organics. The organic and water vapours are drawn off by an induced draft fan. The gas stream is filtered to remove particulates and then condensed. Organics which do not condense are passed through two condensers and activated carbon, where they are removed.

The condensed water/organics are separated by a gravity oil/water separator. The organics are fractionated as "light" and "heavy". The water is treated by carbon filter and used to quench the soil.

Limitations: The LT3 technology is not applicable for treating waste contaminated only with heavy metals. There is no limit on the quantity of moisture in the waste provided; the material can be handled by the screw and other material conveyors as a solid.

Efficiency Description: Up to 99.99% on certain chemical species

Government Funding: SITE, Superfund

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals Has operated on US Superfund sites

Setup/Feed: Setup Time (days): **10** Breakdown Time (days):

Feed Rate Average (Tonne/hr): **0.8**

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): – Average Cost (US$/Tonne): **$150.00**

Database References: ATTIC ☐ VISITT ☒

Emissions / By-Products: <1*10E-3 lb/hr organics; <1*10E-4 lb/hr particulates

Developers:

Roy F. Weston, Inc.
One Weston Way
West Chester, PA
USA 19380-
Notes

Contact: Cosmos, Michael G.
Phone: (610) 701-7423 Ext:
Fax: (610) 701-5035
Email:

Vendors:

Roy F. Weston, Inc.
One Weston Way
West Chester, PA
USA 19380-
Notes

Contact: Cosmos, Michael G.
Phone: (610) 701-7423 Ext:
Fax: (610) 701-5035
Email:

Literature References:

Author: **Cohen, A., Johnson, N.**
Title: Thermal Destruction of Military
Journal: Date:

Author: **Cosmos, M.**
Title: Apparatus and Method for Low Temperature Thermal Stripping of Volatile Organic Compounds from Soil
Journal: U.S. Patent and Trademark Office, No. 4, 738, 206 Date:

Author: **Cosmos, M., Nielson, R.**
Title: Low Temperature Thermal Treatment Technology for Onsite Remediation
Journal: Separation Science and Environmental Chemists Date:

Author: **Velazquez, L., Noland, J.**
Title: Low Temperature Thermal Stripping
Journal: Date:

Author: **Roy F. Weston Inc.**

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Title: Low Temperature Thermal Treatment (LT³®) Technology : Applications Analysis Report
Journal: US EPA 540/AR-92/019 Date: Dec 1992

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Weston Low Temperature Thermal Treatment (LT3) System

20-Jan-98

Project: Crows Landing, Naval Air Station — **Year: 91**

Location: Crows Landing, California, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Naval Civil Engineering Laboratory	Tom Torres	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 3000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Contaminants	Untreated:	Treated:
BTEX	50 ug/g	10 ug/g

Emissions/ByProducts:

Description:

Project: Tinker Air Force Base (Soldier Creek) — **Year: 90**

Location: Oklahoma City, Oklahoma, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
USATHAMA	Wayne Sisk	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 1000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Letterkenny Army Depot — **Year: 86**

Location: Letterkenny, Pennsylvania, USA — Pilot Scale

Client/Funding Agency	Contact	Phone
USATHAMA	Wayne Sisk	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 500

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Ex-Situ Soil

Contaminants Treated:

Emissions/ByProducts:

Description:

Project: Anderson Development Co. — **Year:**

Location: Adrian, Michigan, USA — Full Scale Demo

Client/Funding Agency	Contact	Phone
Anderson Development Company	Jim Huerta	

Not Audited

Feed Rate (Tonne/hr): Amount Treated (Tonne): 3000

Treatment Cost (US$):

Setup Time (days): Breakdown Time (days):

Media Treated: Sludge

Contaminants Treated:

Emissions/ByProducts:

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~~Emissions/ByProducts:~~

Description:

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Xetex Environmental Corporation, Xechlor Process *20-Jan-98*

Technology Type: Chemical TechID: 375

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Dioxins/Furans

Media Treated: Sediment Ex-Situ, Soil Ex-Situ, Sludge

Development Stage: Pilot Scale **Country Of Origin:** USA **Portable:** ☒

Description:

Low temperature catalytic chemical reduction reaction which detoxifies PCBs, dioxins, furans, PAHs and selected explosive materials and poison gases in soil, sediment, sludge and oil matrices.

Process is amenable to be interfaced with polishing technology for the fixation of toxic metals, or detoxification of other degradable compounds.

The reductive nature of the chemical reaction for the Xechlor Process does not lead to the formation of toxic compounds such as chlorinated dioxins and furans.

Results to date include full laboratory, bench scale and pilot scale demonstration of the detoxification of PCB containing materials.

Limitations:

Efficiency Description:

Government Funding:

Environmental Concerns: Uses reactive chemicals

Health & Safety Plan Available: ☒

Regulatory Approvals EPA Region V, TSCA and CRAOA for pilot demonstrations

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$): $5,000,000.

Treatment Cost (US$/Tonne): $100.00 – $1,000.00 Average Cost (US$/Tonne): $250.00

Design of full scale system will be a function of application. System can be designed for feed rates of more than 1000ton/day or a little as 1 ton/day. Based on treatment of PCB with initial level >500ug/g (dry) and final level <25ug/g (dry). Removal efficiency goal of +95%.

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: None known (assessment in progress)

Developers:

Princeton University
Department of Chemistry
Princeton, NJ
USA 08544-
Notes

Contact: Schwartz, Jeffrey
Phone: (609) 258-3926 Ext:
Fax: (609) 258-2383
Email:

Vendors:

Xetex Corporation
One Rockefeller Plaza
New York, NY
USA 10020-
Notes

Contact: Berns, Michael
Phone: (212) 332-3333 Ext:
Fax: (212) 332-3315
Email:

Literature References:

Author: **Liu, Schartz and Cavailaro**
Title:
Journal: Environ. Sci. and Technology, Vol.29, 1995 Date:

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Zimpro Wet Air Oxidation

20-Jan-98

Technology Type: Thermal TechID: 218

Contaminants Treated: PAH's, PCB's, Pesticides/Herbicides, Petroleum Hydrocarbons, Oil & Grease, Heavy Metals, Radionuclides, Tributyl-Tin, Mercury, VOCs

Media Treated: Sediment Ex-Situ, Sludge

Development Stage: Commercial **Country Of Origin:** USA **Portable:** ☒

Description:

Wet air oxidation is a process that accomplishes an aqueous phase oxidation of organic and inorganic substances at elevated temperatures and pressures. The feed streams requirement for water makes this process conveniently adaptable for the treatment of dredged sediment or sludges. Depending upon the temperature and retention times organic contaminants can be fully oxidized to carbon dioxide and water or oxidized to a level where standard biological treatment can be applied.

Sulfur is converted to sulfate, nitrogen to ammonia and halogens to inorganic halides. Metals are generally converted to their highest oxidation state and remain in the aqueous phase as dissolved or suspended solids. PCBs and halogenated aromatic compounds without other non-halogenated groups or catalysts (either organic or inorganic) are relatively resistant to the process.

Zimpro Environmental, Inc. is the commercial developer of the process and provides skid-mounted units in varying sizes from 5.5 m^3/day up, as well as complete pilot testing capabilities. The second vendor, Gore & Storrie, provides various models. In addition, Kenox Corporation (listed in SEDTEC) provides both pilot and full scale models, as well as suppliers in the European Economic Community.

Limitations:

Efficiency Description: Most organic compounds 90%->99%

Government Funding:

Environmental Concerns:

Health & Safety Plan Available: ☐

Regulatory Approvals

Setup/Feed: Setup Time (days): Breakdown Time (days):

Feed Rate Average (Tonne/hr):

Cost: Capital Cost (US$):

Treatment Cost (US$/Tonne): - Average Cost (US$/Tonne):

Database References: ATTIC ☐ VISITT ☐

Emissions / By-Products: Oxidized liquor (to wastewater treatment centre), scrubbed off-gases, solid residue for landfill

Developers:

Zimpro Environmental, Inc.
301 W. Military Road
Rothschild, WI
USA 54474-
Notes

Contact: Copa, W. M.
Phone: (715) 359-7211 Ext:
Fax: (715) 355 3219
Email:

Vendors:

Gore & Storrie Limited
255 Consumers Road
North York, Ontario
Canada M2J 5B6
Notes

Contact: Perkins, Neil
Phone: (416) 499-9000 Ext:
Fax: (416) 499-4687
Email:

Literature References:

Author: **Engleman, V.**
Title: Bench-Scale Evaluation of Zimpro's Wet Air Oxidation Process on Contaminated Sediments from the Grand Calumet River /
Journal: EPA 905-R94-007
Prepared for US EPA ARCS Program Date: **May 1994**

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